SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1913.

GENERAL PHYSICS.

1567. *New Form of Printing Chronograph.* **W. Gaertner.** (Science, 37. pp. 641–642, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—The design is for an instrument capable of recording time in minutes, seconds, and hundredths of seconds, by printing the records in figures on a strip of paper. The minute and second wheels are rotated by two specially designed electromagnets which operate on pawls and ratchet-wheels of 60 teeth. C. P. B.

1568. *Direct-reading Seismograph.* **V. Crémieu.** (Comptes Rendus, 156. pp. 832–835, March 10, 1913.)—By employing the principle of a torsion balance of which the suspending wire is bent at its point of insertion, giving an invariable plane of vibration (see Abstract No. 1377 (1913), a seismograph has been designed by means of which the records may be interpreted directly. Some details of the apparatus are given, suitable for registering all three components of a seismic movement. C. P. B.

1569. *Improvements in Mirror Readings.* **J. Ludwig.** (Phys. Zeitschr. 14. p. 557, June 15, 1913.)—Below the rotating mirror is arranged a fixed mirror which reflects a vernier adapted to the scale. The mirrors are so disposed that the planes of the images of the scale and vernier are the same, and that the images are in contact along a line. With a telescope the vernier gives the usual increase of accuracy. Without the telescope it compensates for the absence of the latter. E. E. F.

1570. *Standardisation of Hydrometers.* **R. T. Glazebrook.** (Nature, 91. pp. 412–413, June 19, 1913. From the National Physical Laboratory.)—Three different methods are in use for the standardisation of hydrometers. The instruments are in all cases graduated for use in a liquid at a definite temperature—the standard temperature of the instrument—and give the specific gravity of this liquid at some definite temperature, which may or may not be the standard temperature of the instrument, referred to water at the same or some other temperature. The following cases have arisen.

I. (α) The liquid to be tested must be at the standard temperature of the instrument, say 85° F. (β) The water to which the sp. gr. is referred must also be at this standard temperature, say 85° F.

II. (α) The liquid to be tested must be at the standard temperature of the instrument, say 85° F. (β) The water to which the sp. gr. is referred must be at some other definite temperature, say 60° F. The sp. gr. of the liquid at 85° F. is then referred to that of water at 60° F.

III. (α) The liquid to be tested must be at the standard temperature of the instrument, say 85° F. (β) The graduations are such that they give the value which would be found for the sp. gr. of the liquid if it were cooled or heated to some other temperature and referred to water at that temperature, say 60° F.

A sugar solution which reads 1·1484 by method I (85° F./85° F.), would read 1·447 by method II (85° F./60° F.) and 1·1500 by method III (60° F./60° F.).

Method III has the obvious objection that the instrument is correctly graduated only for a liquid having one definite coefficient of expansion, and hence cannot be used without error for others. Method I has been the usual practice at Kew. Method II has the advantage that the reference temperature of the water is fixed and gives results in agreement with the usual definition of specific gravity, which assumes a fixed temperature for the water.

The author invites expressions of opinion concerning these different methods from makers and users of hydrometers. T. H. P.

1571. *Optical Coincidences for Time Transmission.* **Schwartz and Villatte.** (Comptes Rendus, 156. pp. 121–124, Jan. 13, 1913.)—To facilitate observation of the standard pendulum, arrangements are made to illuminate the field of a small telescope intermittently at each beat. This is placed close to the eyepiece of a larger telescope which is employed for viewing the signals of other observers at a distance, so that all that is necessary is the observation of coincidence of two intermittent illuminations. A variation of the method is to view the distant signals in the telescope, and judge coincidences with the local timekeeper by listening to the beats with a telephone. C. P. B.

1572. *Azimuth Marks of Cape Transit Circle.* **D. Gill.** (Observatory, No. 459. pp. 184–185, March, 1913.)—Each azimuth mark is defined by the vertical plane passing through the optical centre of an object-glass placed at the bottom of a pit sunk to the unweathered Malmesbury rock many feet below the surface. At the focal plane of this lens there is a horizontal slide carrying two spider threads, or a spider thread and illuminated aperture. Below the object-glass there is placed a trough of mercury, by means of which it is possible to see the reflected images of the spider threads with a small microscope. These threads are adjusted to be at equal distances from the meridian mark, on opposite sides of the meridian, so that when the image of one of them is superposed on the other it is then certain that the meridian mark is exactly on the meridian line. C. P. B.

1573. *Longitude Determination by Wireless Telegraphy.* **H. Renan.** (Comptes Rendus, 156. pp. 758–760, March 10, 1913.)—As intimated in a previous paper [Abstract No. 267 (1912)], the system of exchange of signals by wireless telegraphy has been employed by the observers engaged in determining the difference in longitude between Uccle (Belgium) and the Paris Observatory, and a discussion is given showing the comparative accuracy of the new method and the old system of telegraphy. The conclusion is that the mean error is very nearly the same in the two methods, ± 0·0060 sec. for wireless, and ± 0·0071 sec. for ordinary telegraphy. The time of transmission of an ordinary electric signal from Paris to Uccle is found to be 0·008 sec. The final value for the difference of latitude, Paris (Cassini's meridian) and Uccle (meridian circle) is 8m. 5·12s. C. P. B.

1574. *Influence of Drawing on the Properties of Metallurgical Products.* **L. Guillet.** (Rev. de Métallurgie, 10. pp. 769–777, June, 1913.)—The author has studied the effect of cold work on the mechanical properties and the resistance of metals and alloys to corrosion. Drawing greatly increases the elastic limit and decreases the resilience. Elongation is diminished to a greater extent than the contraction. Experiments have been made on the resistance of Al and some of its alloys, to corrosion in water and different saline solutions of various strengths. Although in a great many cases the cold-worked product is attacked to a greater degree than the annealed product, this is by no means a general law. The action appears to be a function of the alloy and the acting reagent. F. C. A. H. L.

1575. *The Elasticity of Ice.* **K. R. Koch.** (Ann. d. Physik, 41. 4. pp. 709–727, July 17, 1913.)—Nearly 30 years ago the author made numerous determinations of the elastic modulus of ice while on the Labrador coast as a delegate of the German Polar Commission; in spite of good agreement for the same sample, the values for different samples differed appreciably from each other, and, moreover, were greater than those obtained by earlier investigators. The author noticed, however, that in spite of the low temperature prevailing, a considerable decay of the ice-bars took place, which rendered dimensional measurements uncertain. The publication of the results was therefore postponed until further data had been accumulated. Experiments at Freiburg gave a value E = 646·5 kg./mm.², while the average value of the Labrador experiments was 696 kg./mm.². The latter experiments were rejected because it was impossible to determine the relation between the elastic force and its direction to the chief crystallographic axis. Hess's results are quoted with comments thereon. The difficulties due to viscosity are emphasised, since very delicate methods are required for measuring small bars, while the condition of the ice is of great importance. Ice from lakes and ponds is traversed by air-bubbles and channels, which are in planes parallel to the frozen surface, the air-channels being lengthways perpendicular to the latter. Figures are given of ice sections cut from Labrador and Bernina ice. When ice which contains air is used, the bubbles and channels act as if the cross-section was reduced and thereby cause the modulus of elasticity to appear too small. Last winter the author took samples from ice lakes on the Bernina Pass, and experiments, details of which are given, were carried out in the coldest room of the Bernina Hospice where a temperature of −8° to −6° C. prevailed. A photograph of the apparatus employed is given in the paper. The dimensional determinations receive adequate description and all the precautions to ensure accuracy are added, an optical method being employed. The use of a microscope with micrometer is not to be recommended, as the observer's presence would occasion temperature fluctuations which could not be determined. The sources of error lie in the difficulties attending the readings, and in the determination of the permanent deformation due to viscosity. Tables are given, and the sources of error examined and corrected. A general mean value of $E = 625·9$ kg./mm.^{2} for an average temperature of $-7·2°$ C. was obtained, this being fairly near the author's earlier results. It may perhaps be imagined that the elastic modulus is dependent upon the orientation of the ice with respect to the freezing surface, but the results for rods cut in the same direction differ from rod to rod. The greatest value of the deviation for the same rod reached 1 %, but for different rods over 10 % was recorded. Other explanations must therefore be sought to account for these discrepancies, and the author makes two proposals, viz. that the varying temperatures of night and day have caused internal stresses in the ice, the existence of which was proved by the appearance of cracks after 4–5 days; also that in preparing the rod by filing, etc., the temperature is raised and the possibility given for an alteration in crystalline structure on cooling. The above actions would each account for variation from rod to rod. H. H. Ho.

1576. *Precision Viscosimeter: Relative Viscosities of Water at* 0°, 18°, 25°, *and* 50°. **E. W. Washburn** and **G. Y. Williams.** (Amer. Chem. Soc., Journ. 35. pp. 737–750, June, 1913. Contribution from the Laborat. of Physical Chem. of the Univ. of Illinois, Publication No. 14.)—An improved Ostwald viscosimeter of fused quartz has been designed and is found to possess the following advantages: (1) Its water-constant for a given temperature is not altered by cleaning it with hot liquids or by subjection to wide temperature variations; this magnitude has remained constant to within 0·03 sec. after the instrument has been in use for six months. (2) The water-constant at 25° is 580 secs. and is repeatedly reproducible to about 0·03 sec. under constant conditions. (3) For effective pressures within the limits 130–300 mm. of water, the deviation of the viscosimeter from the requirements of Poiseuille's law is less than 0·03 per cent. (4) An error of as much as 1 c.cm. in the amount of liquid introduced into the viscosimeter changes the time of flow by less than 0·05 per cent. (5) A single instrument can be used for a large temperature-range, since its dimensions do not alter with the temperature. The following values have been obtained for the relative viscosities of water at different temperatures: $\eta_{18}/\eta_0 = 0·58978$, $\pi_{25}/\eta_0 = 0·49741$, $\eta_{50}/\eta_0 = 0·30640$, $\eta_{50}/\eta_{25} = 0·61599$, these numbers being probably accurate to 0·03 per cent. The relative viscosity of a normal potassium chloride solution at 18° is 0·98130. T. H. P.

1577. *Viscosity of Air.* **R. A. Millikan.** (Ann. d. Physik, 41. 4. pp. 759–766, July 17, 1913.)—A discussion of the most probable value of the viscosity of air, the following conclusions being reached: (1) To within one in a thousand the viscosity of dry air at 23° C. is $\eta_{23} = 0·00018240$; (2) Between 12° and 30° C. to within one in a thousand, $\eta_t = 0·00018240 - 0·000000493 (23° - t)$. E. H. B.

1578. *Investigation of Molecular Forces by Disturbance of Molecular Equilibrium in Liquid-crystals.* **O. Lehmann.** (Deutsch. Phys. Gesell., Verh. 15. 10. pp. 418–422, May 30, 1913.)—A discussion is given of the conditions under which the elastic limit might be measured in viscous materials such as marine glue. The author maintains that liquid-crystals have no elasticity as the particles rearrange themselves when the mass is deformed and cannot therefore carry a permanent strain. T. M. L.

1579. *The "Rutherford" Atom.* **G. S. Fulcher.** (Science, 38. pp. 274–276, Aug. 22, 1913.)—The paper discusses the theory of Rutherford [Abstracts Nos. 1347 (1911), 1296 (1913)] that an atom has a central concentrated positive nucleus consisting of a number of elementary charges equal to about half the atomic weight. The author considers that for elements of low atomic weight such a simple atom will not explain spectral phenomena. E. M.

1580. *Continuity.* **O. Lodge.** (Chem. News, 108. pp. 127–136, Sept. 12, and pp. 139–148, Sept. 19, 1913. Presidential Address to the British Assoc. at Birmingham, 1913. Science, 38. pp. 379–395, Sept. 19, and pp. 417–430, Sept. 26, 1913. Nature, 92. pp. 33–48, Sept. 11, 1913.)—The author urges a belief in ultimate continuity as essential to science; regards scientific concentration as an inadequate basis for philosophic generalisation; believes that obscure phenomena may be expressed simply if properly faced; and points out that the non-appearance of anything perfectly uniform and omnipresent is only what should be expected, and is no argument against its real substantial existence. L. H. W.

1581. *Flexure of Telescope Mirror-discs arising from their Weight.* **H. S. Jones.** (Roy. Soc., Proc. Ser. A. 88. pp. 494–522, July 1, 1913.)—Mathematical.

1582. *Effect of Temperature in Gravity Determinations with v. Sterneck's Apparatus.* **C. Mineo.** (N. Cimento, 5. Ser. 6. pp. 159–179, March, 1913.)

1583. *Einstein's Stationary Gravitation Field.* **P. Ehrenfest.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1187–1191, May 30, 1913.)—Discusses the hypothesis of equivalence on which Einstein bases his attempt at a theory of gravitation, and which requires a curvature of the rays of light in a field of attraction. The problem is put thus. Let a laboratory L with the observers in it have some accelerated motion with regard to a system of co-ordinates x, y, z, which is not accelerated. Let it, for example, move parallel to the z-axis with some positive acceleration. Then the observers will find that all the inert masses which are at rest with regard to the laboratory exert a pressure on the bodies which are in contact with their bottom side. There are two ways for these observers to explain this pressure: (1) Our laboratory has an acceleration upwards, hence all inert masses press on the bodies under them; (2) our laboratory is at rest, but a field of force acts in it which pulls the masses down. Observations on the course of the rays of light seem to make it possible to decide between the ways (1) and (2), for with regard to the system of co-ordinates x, y, z, the light travels rectilinearly, but with regard to the accelerated laboratory *curvilinearly.*

The author reaches the conclusion that all statical fields of attraction, except those of a very particular class, are in contradiction with Einstein's hypothesis of equivalence. For example, the statical field due to several centres of attraction which are stationary with respect to each other, is not compatible with the hypothesis of equivalence. E. H. B.

1584. *Three Ice Storms.* **C. F. Brooks.** (Science, 38. pp. 193–194, Aug. 8, 1913.)—Two of the ice storms here discussed were observed at Blue Hill in Feb., 1913. In the case of the first a south wind was blowing during the afternoon of the 16th, and this was gradually forced upwards by a cold north-east wind which crept in below it. Rain fell during the night from the upper south wind, and, freezing on trees and other objects in the cold lower current, formed the "ice storm." The second example was of the same type, but in this case the ice attained to a greater thickness (1 in.). In the third example a larger area was under observation. The precipitation underwent a gradual change from deep snow in the north of the observed belt to a thick covering of frozen rain, sufficient to break down small trees, in the south. Ten miles still further south there was no ice or snow.

J. S. Di.

1585. *Correction of Actinometer Measurements for Aqueous Depletion.* **F. W. Very.** (Science, 37. pp. 639–640, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—Tables are given for the approximate correction of actinometric observations with air masses and pressures of aqueous vapour as arguments. More data are required, including simultaneous observations of the distribution of aqueous vapour in the upper air by means of sounding balloon ascensions or high kite flights.

C. P. B.

1586. *Volcanic Dust and other Factors in the Production of Climatic Changes, and their possible Relation to Ice Ages.* **W. J. Humphreys.** (Frank. Inst., Journ. 176. pp. 131–172, Aug., 1913. Mount Weather Observatory, Bull. 6. pp. 1–34, 1913.)—In this paper the author develops the view that the ice ages of the past may have been brought about by increased volcanic activity with a consequent increase in the amount of fine dust in the upper layers of the atmosphere. Theoretical reasoning is brought forward to show that such dust by its scattering and reflecting of radiation might produce a considerable decrease of temperature on the earth's surface. Turning to observational data the author finds that considerable decreases in pyrheliometric readings have followed all the larger volcanic eruptions since reliable records have been kept. The observations suggest that a decrease of 10 % in the total incident radiation at the earth's surface may occur for a time after unusual volcanic activity, and such a falling off as this, if continued for a sufficient period, would cause a decrease of temperature at the surface of the earth of over 6° C. The mean yearly temperature of the earth over the period 1872–1912 is compared with the mean pyrheliometric readings (P), and also with the sun-spot numbers (S), and it is found that by a suitable combination of P with S excellent agreement can be obtained between the combined P and S curve and the temperature curve. A further effect of dust in the earth's atmosphere on temperature would be produced by the radiation from the dust particles to the earth, but the increase of temperature arising from this source is found to be unimportant. It is therefore surmised that continued volcanic activity might, through the dust introduced into the upper layers of the atmosphere, cause a considerable decrease in temperature, and that herein may be found an explanation of the ice ages of the past.

J. S. Di.

1587. *Atmospheric Humidity as related to Haze, Fog, and Visibility at Blue Hill.* **A. H. Palmer.** (Mount Weather Observatory, Bull. 5. Part 4. pp. 231–246, 1913.)

1588. *Determination of the Azimuth and Apparent Emergence Angle of Longitudinal Earthquake Waves.* **H. Benndorf.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 169–188, Jan., 1913.)—Galitzin's method is first referred to, in which he calculated formulæ for determining the azimuth and apparent emergence angle of longitudinal earth waves from the readings of three seismographs having electrical recorders, no limiting assumptions being made as to the nature of the earth surface movement. The formulæ held good, however, only under the following conditions, viz., all three seismographs as well as the three galvanometers must show exactly the same periodic limits, and all six instruments must have equal vibration periods by suitable damping. Since there are few stations possessing Galitzin's instruments, and as it is of great theoretical interest to obtain abundant data for emergence-angle determinations, the author has investigated how the emergence angle may be determined by the ordinary seismographs. Although theoretical determinations at least can be made from seismograph records when the pendulum constants are known, this method is extraordinarily troublesome and protracted. The author has therefore made a series of investigations to explain certain seismographic problems, giving a mathematical exposition with tables of calculations. Simple formulæ are established for the azimuth and emergence angle, which are of practical importance, since it is exceedingly difficult to obtain three seismographs with the same vibration periods and equal damping constants. H. H. Ho.

1589. *Temperature in Deep Wells at Findlay, Ohio.* **J. Johnston.** (Amer. Journ. Sci. 36. pp. 131–134, Aug., 1913.)—The paper contains the results of a series of measurements made at the instance of the United States Geological Survey. The temperatures were found by maximum thermometers previously calibrated at the Bureau of Standards and found not to be in error by more than 0·1 deg. C., which is the limit of their practical accuracy. If only a single thermometer be used, accidental jarring while being raised to the surface might lead to errors the existence of which might not be detected, so to eliminate this possibility of error three thermometers were always used together. The thermometers were enclosed in a special kind of cage exact details of which are given, together with all precautions for eliminating errors due to the apparatus. Temperatures at the bottom of a hole should not be taken until at least 24 hours have elapsed since drilling was discontinued or since water was poured into the hole. The most serious disturbing factor in the attempted determination of the temperature of the rock (as distinct from that of the air or gas in the hole) is the flow of gas, which in expanding cools itself off. This latter influence is evident in the author's measurements, which do not represent the temperatures of the rock at horizons above that of the gas in flow. A table of results is given. The temperature gradient in the sedimentary rocks from the "Trenton" limestone downward is about 0·41 deg. C. (0·74 deg. F.) per 100 feet, while that in the crystalline rocks appears to be somewhat higher, although the data were very insufficient for drawing any very certain conclusions. H. H. Ho.

1590. *Viscosity of Glacier Ice.* **R. M. Deeley** and **P. H. Parr.** (Phil. Mag. 26. pp. 85–111, July, 1913.)—At the outset the authors remark that the question of the flow of glaciers considered as viscous fluid masses has already been dealt with by several investigators, but the absence of reliable data concerning thickness and surface slope has rendered impossible any exact mathematical analysis of their movement. The paper contains an historical survey of the whole subject. The authors point out that it would be a distinct advantage to have a name for the unit of viscosity, and suggest the word "Poise" (after Poiseuille). As compared with the mass of a glacier, the ice granules of which it consists are small and may even more nearly be compared with the molecules of a small volume of such a liquid as oil. Therefore, even though the viscosity of a glacier cannot be considered as quite the same thing as the viscosity of water and other mobile liquids, yet for all practical purposes glacier ice may be regarded as a perfect liquid of high viscosity and will flow until all the stresses are in hydrostatic equilibrium. Although the experiments by McConnell and Kidd in 1888 were carried out with skill and accuracy, they have not hitherto been mathematically examined, and the authors, taking the mean results from the experiments, obtain a viscosity of $24{\cdot}8 \times 10^{12}$ poises. Since the yield must have been at right angles to the optic axes, the high viscosity may be partly due to the low temperature (about −5° C.), to the fact that the bar consisted of a large number of crystalline columns, and that the shear planes were inclined to the direction of the stress. Blümcke and Hess observed the ice velocity of the Hintereis Glacier along a number of lines drawn across the glacier, the rate of ablation and the altitude of its various parts, and by the help of borings they attempted, with certain hypothetical considerations, to construct sections of the glacier showing its width and depth at certain positions. The main objection to their method is that they assume, in the first place, that the velocity is the same in all vertical lines, which would make the glacier too shallow since the glacier slips bodily and also flows differentially. The velocity also at any point on the surface does not depend entirely on the ice thickness at that place, but is affected by the depth of the ice at all points of the section, and, to a certain extent, on the shape of the under surface of the glacier above and below the section. However, the sections are the most accurate yet obtained. The authors propose to discuss the data furnished by Blümcke and Hess, with a view to calculating the viscosity of the Hintereis Glacier. The conditions of flow of viscous fluids are only known for certain shaped channels such as along semicircular or elliptic channels, or channels of width great as compared with depth. In the case of the Hintereis Glacier the stream is somewhat deep as compared with the width, and the form of section departs markedly from that of an ellipse. Weinberg's method was to find an ellipse which is the equivalent of the glacier-bed. Changes occur from time to time in the velocity of glacier flow, these being intimately connected with their varying advances and retreats resulting from periodical alterations in the amounts of precipitation, ablation, or other causes. During retreats of the glacier snout the velocity and thickness decrease, whilst during its advance they increase. The velocity corresponding to the steady state occurs at some time between a period of maximum and minimum velocity, and our knowledge of the seasonal variations of glacier flow is by no means complete. Great interest attaches to the winter velocity where the conditions are more equable than in summer. The amount of slip between ice and rock-bed is a most important but difficult value to ascertain, and only approximations can be given. The resistance offered to the flow of a glacier is of two kinds, viz. the frictional resistance of the floor, and the resistance offered by the ice to change of shape. Very little is known concerning the coefficient of friction of glaciers upon their beds, while it is not clear why a glacier slips at all considering the slight slope. Calculations give 52·2 % as the probable slip at the middle and 68·7 % at the sides. Other values of the slip are discussed by the authors from different sets of observations. The force producing motion results from the slope of the glacier, which can only be obtained by empirical methods; the downward component of gravity, however, is assumed as being proportional to the slope of the upper surface of the glacier, since the difference between the slope of the upper surface and that of the glacier-bed cannot differ very much. The viscosity of glacier ice is then calculated, and while Weinberg obtained his result by fitting to the section of the glacier a semi-ellipse which he regarded as its equivalent, the present authors give a method by which the ellipse may be accurately fitted to the channel. A form of curve is also described and used for calculating the viscosity, which resembles that of a glaciated valley section much more closely than does an ellipse. Generally speaking, the form of a well-glaciated valley very closely approximates to a parabola, but the conditions of viscosity flow have not yet been ascertained for a parabolic channel. The value for the viscosity is given at 125×10^{12} poises, a table of results by other authors being added. The great defect of the ellipse as a basis for comparison lies in the fact that the boundary is vertical at the sides (for the solution has only been found for the complete semi-ellipse), whilst the sides of a natural valley are sloping. The chief reasons for the figures obtained being so much greater than those of Weinberg are: that the velocity is much less, more slip is allowed, the ice-slope is steeper, and the viscosity is the winter-value when the glacier is probably in an equally dry condition from top to bottom. Numerous curves and tables are given. H. H. Ho.

1591. *Microseismic Oscillations and Surface Waves.* **C. Mainka.** (Phys. Zeitschr. 14. pp. 555–557, June 15, 1913.)—At Irkutsk, the amplitude of the horizontal microseismic oscillations is 0·5 μ at the most, and the most usual period is 5 secs. The amplitudes at Pulkowa, Graz, and Göttingen are somewhat larger, but smaller than those at Strassburg. The periods tend to be shorter in summer than in winter, when 9-sec. periods are sometimes found. Some connection is indicated with sea-waves, but not with the direction of the wind. The chief plane of oscillation is east and west. The mean ratio of horizontal to vertical amplitude is 1·1, but more data are required. [*Errata*, ibid. p. 728, Aug. 1, 1913.] E. E. F.

1592. *Colours of the Atmosphere.* **A. Heim.** (Archives des Sciences, 35. pp. 173–183, Feb., 1913.)—Discussing the varying colours presented by atmospheric glare, dependent largely on the intensity and direction of the incident light on the particles, attention is drawn to the appearances at different altitudes and to the question of how estimation of distances is affected by these mist or dust colours. The varying tints and structure of the rays often seen projected through the atmosphere when the sun is hidden by clouds or hills are also described; these features are especially prominent during stormy weather, when the proportion of water-vapour in the atmosphere is relatively high. The phenomena observed at sunrise and sunset are examined in some detail. Illumination of the higher atmosphere, diffuse reflection, and diffraction, are all called in to explain the effects recorded. C. P. B.

1593. *Conditions of Equilibrium of the Solar Atmosphere with respect to the Repulsive Force of Radiation.* **G. Gouy.** (Comptes Rendus, 157. pp. 186–191, July 21, 1913.)—The author points out the long-established fact that exterior layers of the sun are much more extended than gravity or Mariotte's law demands. For example, a difference of level of 32 km. for hydrogen at 8000° absolute should alter the pressure by half, and therefore a difference of 5000 km. would give for the pressure ratio a number approaching $(\frac{1}{2})^{156} = 10^{-47}$. A layer of hydrogen which has a pressure of 1 atmo. at the surface of the photosphere should therefore have a density practically nil at 5000 km. distance. At the latter point, however, the spectrum of hydrogen is always shown with intensity. Accordingly the author has examined the influence which radiation-pressure may exercise on gases and solar vapours. This radiation-pressure has often been considered as the cause of the corona dust. Its existence for absorbing gases has been established by Lebedew's experiments, which determined that the force exercised upon the gas is the same as that upon a dark body for an equal amount of radiant energy absorbed. The author then gives an elementary mathematical demonstration of this result, different cases and assumptions being exhaustively discussed. It follows from the investigation that the repulsion exercised by radiation upon the metallic vapours of the sun should be taken into consideration, although a definite value cannot be assigned to it in the absence of data. This repulsion is important for spectrum analysis, since it is opposed to the weight. It is therefore natural that sodium, which at very elevated temperatures possesses this property to a high degree, is to be found at an exceptional height in the solar atmosphere. Metallic vapours, in general, produce absorption rays without special conditions, but the majority of gases proper (such as hydrogen, helium, etc.) must be rendered active by electrical action before absorption is sensible, so that the gaseous molecules will exert repulsion on each other. If the electrical conditions, which render a gas active, cease to exist above a certain height, the repulsion will also cease. It is therefore not impossible that a gas will accumulate by this mechanism in the exterior solar zones without escaping, and this perhaps explains the anomalous helium spectrum, since the density is then supposed a maximum at a certain height. H. H. Ho.

1594. *Diminution of Solar Radiation during* 1912. **D. Eginitis.** (Comptes Rendus, 156. pp. 855–857, March 17, 1913.)—Quoting an observation of Wolf at Heidelberg (Ast. Nachr. No. 4587), that towards the end of June, 1912, a greyish-white veil appeared to cover the sky, accompanied by a series of vivid twilight colours, producing a brownish tint over the sun and moon, and reducing the light of stars by two magnitudes, a discussion is given of the heliographic records made at Athens during the period in question. Systematic variations of the traces are described, which appear to have been closely accordant in time with the other phenomena. C. P. B.

1595. *Physical Interpretation of Corona Spectrum.* **J. W. Nicholson.** (Observatory, No. 458. pp. 103–112, Feb., 1913.)—A discussion is given of the application of recently developed physical theories to several outstanding astronomical problems, chiefly in relation to the spectra of nebulæ and the solar corona. In the case of the corona spectrum, it is found that the pairs of lines corresponding to a charged nucleus with five times the charge of an electron, surrounded by 3, 4, or 5 electrons, are all represented by corresponding ratios of known coronal spectrum lines. This nucleus has 5 electrons when it is electrically neutral. Attention is drawn to the important theory developed by Planck, in which the radiation from an energised system is emitted discontinuously; resulting from this the spectrum under consideration should contain a series of lines, such that the cube roots of their wave-lengths are in arithmetical progression. This condition is satisfied by the lines λλ5078, 4725, 4400, 4087, ——, 3505, within experimental limits of error. C. P. B.

1596. *Solar Rotation in* 1911. **J. S. Plaskett and R. E. De Lury.** (Astrophys. Journ. 37. pp. 73–104, March, 1913.)—The region of spectrum allotted to the Dominion Observatory, Ottawa, Canada, for investigations of the solar rotation is in the yellow-green, λ5500–λ5700. This subdivision of the work was arranged at the Solar Union Conference at Mount Wilson in 1910, while for general comparison a region common to all observers was that from λ4230 to λ4280. Fifteen to twenty lines are measured in the special region, selected so as to include as many elements as possible, especially those of high or low atomic weight; about ten lines are examined in the special region. The spectroscopic equipment comprised a 20-in. cœlostat, with secondary mirror, giving a horizontal beam north and south to a concave mirror, 18 in. diam. and 80 ft. focus. The spectrograph is of the Littrow form, having a combined collimator and camera objective of 6 in. aperture and 23 ft. focal length. A long discussion is given of the differences of measurement by different observers, the conclusion being that it is at present impossible to discriminate between small personal errors and differences due to a real variation of the solar rotation. The velocity formula determined from Plaskett's measurements is—

$$V = (1{\cdot}488 + 0582 \cos^2 \phi) \cos \phi\,; \quad \xi = 10{\cdot}32^\circ + 4{\cdot}05^\circ \cos^2 \phi,$$

with an uncertainty of from 2 to 3 %. No systematic difference of velocity for different elements is present in the Ottawa measurements. C. P. B.

1597. *Refraction by Solar Atmosphere.* **R. S. Capon.** (Roy. Astronom. Soc., M.N. 73. pp. 361–369, March, 1913.)—From an analysis of the motions of sun-spots it is suggested that there appears to be evidence of their position being influenced by their position on the sun's disc with respect to the earth, and the effect is ascribed to refraction in the solar atmosphere. From the Greenwich photoheliograph measures the heliographic latitudes of spots at longitudes 30° east and west of the central meridian were tabulated, and the mean of the two values compared with the latitude of the spot as it passed the central meridian. From a table of the differences it appears that as a spot crosses the sun's disc it moves towards the pole of the hemisphere in which it is situated, until it reaches the central meridian, when the motion is reversed, and for the remainder of its path it moves away from the pole, and this effect becomes more marked as the latitude increases. Evidence is also found for an apparent decrease of angular velocity as the longitude distance from the central meridian increases. C. P. B.

1598. *Measurements of Solar Radiation.* **C. G. Abbot.** (Astrophys. Journ. 37. pp. 130–144, March, 1913.)—Criticism of the author's measurements of solar radiation has been made by F. W. Very [Abstract No. 988 (1913)]. This the author now takes in detail and seeks to show its fallacy. One of the critic's points was that the Smithsonian method would be sound if the atmosphere remained of uniform transparency during the period of observation and if the bolometer could measure homogeneous rays, and these conditions are claimed to exist. C. P. B.

1599. *Circulation in Solar Atmosphere.* **F. Slocum.** (Science, 37. p. 642, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America. Astrophys. Journ. 37. pp. 354–358, June, 1913.)—Based on a study of 4600 solar prominences which by their form or movement indicate a horizontal circulation in the solar atmosphere, a series of results were given, classified into groups according to direction, latitude, and height above chromosphere. Only the north-south components of the movements are measured at present from the spectro-heliograms, but it may be possible later to apply the east-west components from radial velocity determinations. C. P. B.

1600. *Types of Prominences Associated with Sun-spots.* **[Mrs.] M. A. Evershed.** (Roy. Astronom. Soc., M.N. 78. pp. 422-430, April, 1918.)—Referring to the photographs published by Slocum [Abstract No. 368 (1918)], which show distinct evidence of the flow of prominence matter towards the centre of a large spot then on the solar limb, the difficulty of identifying any particular feature on successive plates is mentioned, and as wherever any certain evidence of motion has been detected, it has generally been outwards, the single instance quoted cannot be taken as typical of the attraction of sun-spots for prominences. A series of photographs are reproduced showing various types of prominence action, and from a close study of these it is concluded that the motions of prominences situated directly above sun-spot groups are of quite a different nature to those in the penumbra of spots. The gases rise from the centre with velocities about 12 km. per sec., and some distance away this diminishes to 2-8 km. per sec. The outward-moving gas seems to have a tendency to fall back upon the chromosphere. C. P. B.

1601. *Frequency of Prominences on East and West Solar Limits.* **J. Evershed.** (Kodaikanal Observatory, Bull. No. 28. Nature, 91. p. 281, May 15, 1918. Abstract.)—Resulting from an extensive inquiry there appears to be abundant evidence of a distinct predominance of prominences at the eastern limb of the sun, with suggestions of an annual periodicity of the effect, having maxima in Jan. and Aug. and minima in April and Nov. Metallic prominences, and those showing displacement of the hydrogen lines show a still greater difference than the quiet prominences. C. P. B.

1602. *Sun's Polar and Equatorial Diameters.* **R. P. S. Chevalier.** (Ann. de l'Observatoire Astronomique de Zô-sè (China) 6. Nature, 91. p. 225, May 1, 1918. Abstract.)—From a series of photographic records covering the period 1905-1910 it is found that the sun's polar diam. is greater than the equatorial one, the difference appearing to be variable. The mean difference is given as + 0·19″. C. P. B.

1603. *Substitute for Bode's Law.* **[Miss] M. A. Blagg.** (Roy. Astronom. Soc., M.N. 78. pp. 414-422, April, 1918.)—Starting with the original idea of a geometrical series, tables are constructed showing the analysis of the log-differences corresponding to the distances of the planets in the solar system, the satellite systems of Jupiter and Saturn, and a remarkable similarity is found between the "variation of distance" curve in all three systems. The curve of variation is illustrated, and it is significant that the places for the minor planets and Saturn's rings are almost exactly the two positions of max. slope on the curve. One of the physical conclusions affecting the problem is that if the distances of the planets and satellites obey with tolerable fidelity a regular law which has the same features for systems so different as those of the sun and Jupiter, this law probably applies to the original distances and not to the distances as modified by tidal action or mutual perturbation. This view accords very closely with the opinion expressed in 1881 by G. Darwin from quite different considerations. C. P. B.

1604. *Visual Search for Minor Planets.* **J. Lagrula.** (Comptes Rendus, 156. pp. 1184-1186, April 14, 1918.)—The principal difficulty attending the search for new minor planets is owing to their being so nearly like stars of about the same magnitude; when their relative motion is sufficiently rapid, this constitutes the most reliable method of distinguishing them: by employ-

ing the simple device of a binocular eyepiece, one showing the ordinary image of the star field while the other is arranged to give a view of a positive copy of the star region under examination. This is illuminated by coloured light, so that when lightly displaced one would see a group of stars, with a similar group of coloured stars, each in similar position to its respective real object. Then if the coloured images are accurately superposed on the real star-images, it becomes a simple matter to examine the field of view rapidly for any points of white light still remaining, when there may be either new objects or planets whose movement might soon be investigated.
C. P. B.

1605. *Total Solar Radiation during Annular Eclipse.* **W. H. Julius.** (Astrophys. Journ. 37. pp. 225-238, May, 1913. Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1451-1468, July 15, 1913.)—During the annular eclipse of the sun on April 17, 1912, the variation of the total solar radiation was observed near Maastricht under favourable sky conditions, with two mutually independent sets of apparatus. One set, comprising a bolometer and a short-period recording galvanometer, was employed in finding the proportion of the minimum to the maximum radiation. This ratio was found to be nearly 1 : 5000. On this was based an estimate of the total amount of energy radiated and scattered by the entire solar atmosphere, giving about 1 : 1000. It would apppear impossible, therefore, to ascribe the fall of the sun's brightness towards the limb of the disc to absorption or scattering of the light by an atmosphere enveloping a body that would otherwise appear uniformly luminous. With the other set of apparatus, consisting of a thermopile and accessories, a sufficient number of readings were obtained for constructing the whole radiation curve from the first until the fourth contact. C. P. B.

1606. *Variation of Solar Radiation.* **C. G. Abbot, F. E. Fowle,** and **L. B. Aldrich.** (Astronom. Nachr., No. 4656. Nature, 91. p. 381, June 12, 1913. Abstract. Washington Acad. Sci., Journ. 3. pp. 309-315, June 4, 1913. Meteorolog. Zeitschr. 30. pp. 257-261, June, 1913.)—About 700 observations have now been secured by the Smithsonian observers at altitudes varying from sea-level to 4420 m. A preliminary discussion of these leads to the following conclusions :—(1) The mean value of the solar constant of radiation for the epoch 1905-12 is 1·929 cals. per sq. cm. per min. (2) An increase of 0·07 cal. per sq. cm. per min. accompanies an increase of 100 sun-spot numbers (Wolfer). (3) An irregular variation frequently ranging for more than 0·07 cal. per sq. cm. per min. within an interval of 10 days appears to be established from nearly simultaneous measurements at Mount Wilson in California, and Bassour in Algeria. C. P. B.

1607. *Enhanced Lines in Early Spectrum of Nova Geminorum* (1912). **H. F. Newall** and **F. J. M. Stratton.** (Roy. Astronom. Soc., M.N. 73. pp. 380-382, March, 1913.)—From detailed comparisons of the spectrum of Nova Geminorum (No. 2) obtained at Cambridge in March and April, 1912, with the spectrum of *a* Cygni a close resemblance has been noted between the early absorption spectrum of the Nova (1912, March 15) and the *a* Cygni spectrum. The agreement is of the same order as that found by the Kensington observers for the bright-line spectrum of Nova Persei. The identification has been made on the assumption that the strong absorption lines of the Nova are all displaced towards the violet. Of the 65 lines of intensity 2 or more given by Miss Maury for α Cygni between H_β and $\lambda 4063$, 50 are well identified in the Nova absorption spectrum. This is well shown on a reproduction of the two spectra placed side by side. From a study of the comparative intensities of the lines, it appears that the Nova spectrum is intermediate in type between α Cygni and γ Cygni. The elements represented by their enhanced spark lines are titanium and iron certainly; also most probably vanadium, scandium, and strontium; chromium and zirconium somewhat doubtful. C. P. B.

1608. *Spectrum of Nova Geminorum* (1912). **F. C. Jordan.** (Allegheny Observatory, Univ. of Pittsburg, Publ. 3. No. 3. Nature, 91. p. 252, May 8, 1913. Abstract.)—Description of 18 spectrograms of Nova Geminorum (1912), with wave-length tables and intensity curves. From measurements of the H and K absorption lines, the weighted means of the deduced velocities yield a curve which follows to some extent the light-variations of the Nova, the velocities being positive when the star is brighter and negative when it is fainter. C. P. B.

1609. *Parallax of Nova Geminorum* (1912). **F. Slocum.** (Roy. Astronom. Soc., M.N. 73. pp. 437–440, April, 1913.)—Observations for parallax were made from fifteen plates exposed during the period 1912, March 18–1913 March 9. Two exposures were made on each plate, varying from 6 to 15 mins., according to the transparency of the atmosphere, etc. The resulting value of the parallax is + 0·011″, corresponding to a distance of 296 light-years. C. P. B.

1610. *Spectrum of Nova Geminorum* (1912). **F. Küstner.** (Astronom. Nachr. No. 4654. Nature, 91. p. 357, June 5, 1913. Abstract.)—An analysis of 241 lines in the spectrum of Nova Geminorum (1912) results in the suggested presence of lines of uranium, titanium, and blue argon. Radium, manganese, and zirconium may be present, but no evidence is found for emanation, iron, or vanadium. Calcium and helium are also accepted as present, and magnesium doubtfully. C. P. B.

1611. *Distribution of Bright Stars in Space.* **A. S. Eddington.** (Roy. Astronom. Soc., M.N. 73. pp. 346–358, March, 1913.)—Dealing with stars brighter than 5·8 magnitude, and examining those of spectral type A and K separately, the proper motions have been investigated for two regions, one typical of high galactic latitudes, and the other of low. The method has been most successful with the K type stars. With these the numbers appear to accord well with the usually accepted views of stellar distribution. It is supposed that near the sun the actual density of the stars is fairly uniform; that in the plane of the Galaxy this uniform distribution extends a great distance, whilst in directions perpendicular to this plane the density begins to thin out rather rapidly. From the figures given it appears that there is little difference in the two directions until a parallax of 0·01″ is reached; after that the decrease of density in the high latitude becomes more and more noticeable, so that at a parallax 0·004″ it is not more than a third of the density in the galactic planes. C. P. B.

1612. *Northern Durchmusterung.* **E. C. Pickering.** (Science, 37. pp. 640–641, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—One of the greatest needs of astronomy at the present time is the extension of the work of the Cape Photographic Durchmusterung to the North Pole. A plan has been prepared for taking the necessary photographs at Harvard, with the 16-in. Metcalf telescope, using curved plates. The photometric and photographic magnitudes, on a uniform scale, will be determined for a number of standard stars on each plate, and the whole then sent to Kapteyn for measurement and reduction. If completed, the catalogue will contain 800,000 stars or more. C. P. B.

1613. *Distribution of Carrington's Circumpolar Stars.* **F. W. Dyson.** (Roy. Astronom. Soc., M.N. 78. pp. 884–845, March, 1918.)—An attempt is made to investigate the law of distribution of stars in space according to distance, by comparisons of the observed angular velocities or proper motions with the probable law of distribution of the linear velocities. The resulting values are tabulated, and also plotted as a curve showing numbers of stars at various distances indicated by their respective parallaxes. The most important feature shown by this is the comparatively close limits of parallax within which most of the stars lie; 70 % having parallaxes between 0·005″ and 0·0015″. A determination is also made of the distribution of absolute luminosities; that is, the number of stars of given luminosity as compared with the sun, in unit spaces. C. P. B.

1614. *Provisional Orbits of Y Piscium and RR Draconis.* **H. Shapley.** (Astrophys. Journ. 87. pp. 154–168, April, 1918.)—A large majority of the eclipsing binaries whose light decreases more than one magnitude at principal minimum are composed of bright primary stars with larger faint companions. The determination of the secondary spectra is of importance in assigning the relative masses, but in many cases the duration of the minimum phase is too short to permit the making of a spectrogram. Details are given of an attempt to utilise the colour index method by observing the difference between the visual and photographic ranges. [See also Abstracts Nos. 380, 947 (1918).] Evidence is given for regarding the darker components of eclipsing systems as much less dense than their bright companions, and therefore probably they are younger bodies. C. P. B.

1615. *Galactic Motions of Bright Stars.* **H. C. Plummer.** (Roy. Astronom. Soc., M.N. 78. pp. 450–470, April, 1918.)—In continuation of former papers [Abstract No. 785 (1918)] the radial velocities of the bright stars of Type A are discussed in relation to their projected components on the plane of the Milky Way. The results are also summarised in the form of *hodograms*, representing the velocities of the stars at a given epoch. C. P. B.

1616. *Scale of the "Yerkes" Actinometry.* **J. A. Parkhurst.** (Science, 87. p. 641, April 25, 1918. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—A new determination of the absolute scale for photographic magnitudes indicates that the published scale may be extended by about 6%. The application of this correction brings the magnitudes into better agreement with the Harvard values. C. P. B.

1617. *Photographic Chart of Milky Way.* **C. Easton.** (Astrophys. Journ. 87. pp. 105–118, March, 1918.)—Drawings have been made from the available photographs of the Milky Way, and combined into one chart on a spherical projection so as to indicate the general aspect of the whole galactic structure. The discussion of the form is based on the spiral-structure theory, and a hypothetical spiral is centred on the drawing for illustrating the points considered. There appears to be no evidence of the existence of *continuous*

masses of opaque matter lying between the earth and the stars. Comparison of the types of convolutions found in the Galaxy with those of well-known spiral nebulæ suggests that our sidereal system is in an advanced stage of development, approaching rather to the type of M 101 than to that of M 51.
C. P. B.

1618. *Real Brightness of Variable Stars.* **H. N. Russell.** (Science, 37. pp. 651–652, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—The number of variables and of stars having peculiar spectra contained in Boss's Preliminary General Catalogue is large enough to enable an approximate estimate of their mean distance and real brightness to be made by the method of parallactic motion. Tables are given showing the computed values for six groups of variables. C. P. B.

1619. *Algol-variable RR Draconis.* **F. H. Seares.** (Astrophys. Journ. 37. pp. 204–221, April, 1913. Contribution from the Mount Wilson Solar Observatory, No. 68.)—Comparison of photographic results for this star [Abstract No. 576 (1913)] with the incomplete visual light-curve indicated that the photographic variation is greater than the visual. A further examination of the relative dimensions and light-intensities of the two objects composing the system made it practically certain that the difference must be real, and this has been confirmed by photographs taken during the minimum of Sept. 10, 1912, made alternately on ordinary and isochromatic plates, the latter being used with a yellow filter. The total number of exposures was 81, covering the minimum and parts of both branches of the curve, extending over an interval of 5h. 27m. Examination of the variation of colour index shows that the darker component of the system is redder than the brighter component by an amount corresponding to 1·3 times the interval separating successive spectral classes. C. P. B.

1620. *Eclipsing Binary ε Aurigæ.* **H. Shapley.** (Science, 37. pp. 646–647, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—A study of the light curve of ε Aurigæ, period 27·1 years, leads to the conclusion that it is an eclipsing binary. The eclipse is total, the small bright star being hidden for more than a year behind the faint companion. C. P. B.

1621. *Rate of Light-changes in Various Celestial Objects.* **S. I. Bailey.** (Science, 37. pp. 644–645, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—The cluster M3 shows some remarkable examples of variable stars with great rates of increase of light. On a photograph taken with the 13-in. Boyden refractor about 1200 stars are shown, 900 of which were examined for variability, resulting in the detection of 137 objects showing changes. Among these variables the max. rate of increase appears to be more than 6 magnitudes an hour. The mean rate of increase is about 2¼ magnitudes an hour. C. P. B.

1622. *Spectrum of R Lyræ.* **S. Albrecht.** (Science, 37. p. 641, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—From a study of two series of three-prism spectrograms of R Lyræ taken at the Lick Observatory, it is concluded that the radial velocity is —27·22 km. per sec., and that it is constant or nearly so. The spectrum is indexed as somewhat later than type Md. C. P. B.

1623. *Spectroscopic Binary.* BD — 1° 948. **Z. Daniel.** (Astronom. Nachr. No. 4633. Nature, 91. p. 122, April 3, 1913. Abstract.)—This star shows the same peculiarity with regard to the K line of calcium that is exhibited by δ Orionis, in that this line does not indicate motion in the line of sight. The Harvard magnitude is 5·87, and spectrum type B2, and it is interesting to note that this star is less than a degree from δ Orionis. C. P. B.

1624. *Stellar Radial Velocities.* **W. S. Adams.** (Science, 37. pp. 643–644, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—Spectroscopic notes are given of results obtained in the course of regular radial-velocity work with the 60-in. reflector at Mount Wilson. Two photographs of the spectrum of Lalande 15290, Mag. 8·2 G type, are interesting in that they show that its radial velocity is the largest of any star observed to date in the northern sky, varying from — 241 to — 250 km. Observations of a number of the brighter stars in the λ and χ Persei clusters lead to the conclusion that most of these stars have nearly the same radial velocity and apparently are moving together. In Nov. the radial velocity of Nova Geminorum (1912) was found to be about + 5 km. per sec. C. P. B.

1625. *Radial Velocity of a Coronæ Borealis.* **K. Schwarzschild.** (Astronom. Nachr. No. 4646. Nature, 91. p. 253, May 8, 1913. Abstract.)—Description of experiments in determination of radial velocities by Wood's method of interposing an absorbing cell of neodymium chloride near the photographic plate of an objective-prism spectrograph. Probable error about ± 5·7 km. per sec. A period of 17·36 days is indicated. C. P. B.

1626. *Radial Velocity of 63 Tauri.* **K. Schwarzschild.** (Preuss. Akad. Wiss. Berlin, Ber. 16. pp. 306–307, 1913.)—Experiments are described having for their object the determination of radial velocities with objective-prism spectrograms, and details are given of measurements made on spectra of the star 63 Tauri. C. P. B.

1627. *Radial Velocity of a Persei.* **J. H. Pitman.** (Lick Observatory, Bull. 224. Nature, 91. p. 121, April 3, 1913. Abstract.)—From a discussion of the available data for the elements of this star the author concludes that the radial velocity is either constant or only minutely variable. C. P. B.

1628. *Reversals of Calcium Lines in Stellar Spectra.* **G. Eberhard** and **K. Schwarzschild.** (Preuss. Akad. Wiss. Berlin, Ber. 16. pp. 308–310, 1913.)—Discussion of the occurrence of fine reversals in the H and K lines of calcium on photographs of the spectra of certain stars. C. P. B.

1629. *Spectra of Gaseous Nebulæ.* **A. J. Cannon.** (Science, 37. pp. 642–643, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—Examination of the spectra of 140 gaseous nebulæ results in their being divided into three sub-classes. The principal of these may be represented by N. G. C. 7662, having nebular lines strong, 3726, 3729 very faint, and 3869, 4686 well marked. A second class has the strongest line in the violet at 3727, possibly a blend of 3726, 3729, while the chief nebular lines are feebler. D.M. —12° 1172 is the typical object of this division. A third division has 4686 for its strongest line, N.G.C. 60 being typical. This class is of special interest owing to a possible connection with the spectra of class O. C. P. B.

1630. *Path of the Great Detonating Meteor of September 23, 1910.* **G. v. Niessl.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1883-1936, Nov., 1912.)

1631. *Fireballs and Shooting Stars.* **W. F. Denning.** (Roy. Astronom. Soc., M.N. 73. pp. 395-400, March, 1913.)—Detailed examination of the principal meteor showers for many years past yields material for deducing mean values of the velocity, height, length of path, etc. The Leonids appear to be usually about 2 miles higher than the Perseids, owing probably to their greater velocity, the observed rates being 47·9 and 38·8 miles per sec. respectively. From a discussion of measurements of 550 fireballs and shooting stars observed in the United Kingdom since 1886, the following mean data are obtained :—

Height at appearance, 72·1 miles.	Length of path 60·4 miles.
„ disappearance, 46·3 miles.	Velocity per sec. 27·3 miles.

C. P. B.

1632. *Radial Velocity Determinations with Objective Prism.* **F. Schlesinger.** (Amer. Philosoph. Soc., Proc. 52. pp. 175-183, April, 1913.)—Owing to the irrationality of dispersion in prismatic spectra, the length between two predetermined lines will be changed according to the radial velocity of the light source, and with the object of developing a method of utilising the great efficiency of the prismatic camera for stellar spectra work it is proposed to make systematic measurements of the distance between two lines widely separated in the spectrum. This has been suggested by Pickering (*Harvard Annals*, 26. p. 21), but apparently has not been put into practice. Two other methods are also reviewed, and the hope is expressed that the work may be taken up in the near future. C. P. B.

1633. *On the Real Temperatures of the Stars.* **C. Nordmann.** (Comptes Rendus, 156. pp. 1355-1356, May 5, 1913.)—Rosenberg's results, dependent upon spectroscopic observations, are, in the following table, compared with the author's results, which are based upon the application of his heterochromatic photometer to the visual rays :—

Name of Star.	Real Temperature in degrees abs.		Spectral Type, after Lockyer.
	Nordmann. Based on radiations of 460 to 680 μμ.	Rosenberg. Based on radiations of 400 to 500 μμ.	
δ Persei	13,500	15,500	Algol
ε Persei	15,200	23,000	Crucien
β Persei (Algol)	13,300	12,000	Algol
α Lyræ (Vega)	12,200	22,000	Sirius
α Persei	8300	6500	Polaris
α Ursæ Minoris (Polaris)	8200	5200	Polaris
α Canis Minoris (Procyon)	6800	7000	Procyon
γ Cygni	5620	5100	Polaris
Sun	5320	4950	Arcturus
α Aurigæ	4720	4500	Arcturus
β Andromedæ	3700	2650	Antares
α Tauri	3500	2150	Aldebaran

The agreement, except for α Lyræ, is considered remarkably close. In the author's results, the probable error is proportional to the temperature. The agreement goes to prove that the stars behave as black bodies from one end of the spectrum to the other. Probably the discrepancy in the case of α Lyræ is due to selective absorption of the atmosphere of that star. The figures obtained by Rosenberg and the author confirm N. Lockyer's thermal classification. H. F. H.

1634. *Recent Observations of Novæ.* **E. E. Barnard.** (Astronom. Nachr. No. 4655. Nature, 91. p. 382, June 12, 1913. Abstract.)—All the Novæ presenting features distinguishable at the present time have been specially examined, and the details of magnitude, peculiarities of focus, etc., are given in a table extending from T Coronæ (1866) to Nova Geminorum (1912). C. P. B.

1635. *The Hottest Stars.* **A. Pannekoek.** (Astronom. Nachr. No. 4657) Nature, 91. p. 487, July 10, 1913. Abstract.)—A close degree of correspondence is found between the spectrophotometric results of H. Rosenberg for certain stars and the class number of the spectral type according to the Harvard classification of Miss Maury. C. P. B.

1636. *Intensity Distribution of Lines in Stellar Spectra.* **K. F. Bottlinger.** (Astronom. Nachr. No. 4662, p. 117. Nature, 91. p. 568, July 31, 1913. Abstract.)—Measurements of the structural intensity of stellar spectral lines have been made with a Hartmann microphotometer at the Potsdam Astrophysical Observatory. The work consisted chiefly in the study of H_γ and a few other lines in the spectra of α Canis Majoris, α Cygni, η Leonis, ζ Orionis, δ Orionis, and γ Cassiopeiæ. The results are presented in a series of curves representing the distribution of intensity. C. P. B.

1637. *Stars with Peculiar Spectra.* **[Miss] A. Cannon.** (Harvard Circular 178. Nature, 91. p. 539, July 24, 1913. Abstract.)—The note contains details of 10 new peculiar stars having bright-line spectra, and 24 stars with composite spectra. Of these latter only four are included in Burnham's General Catalogue of Double Stars. In the same circular it is noted that a photograph of the spectrum of Nova Geminorium (1912) taken on April 5, 1913, shows only slight changes since Nov. 9, 1912, when the brightest band was λ4363. Between λ4686–λ5007 the spectrum resembles the prevailing type of gaseous nebulæ, but differences occur in other portions of the spectrum. C. P. B.

1638. *Periodic Spectrum of α Canum Venaticorum.* **A. Bélopolsky.** (Astronom. Nachr. No. 4664. Nature, 91. p. 539, July 24, 1913. Abstract.) —Details of the epochs of maximum intensity of the dark line λ4129·03. The period of variation is about 5·50 days. C. P. B.

LIGHT.

1639. *Cassegrain Reflector with Corrected Field.* **R. A. Sampson.** (Roy. Soc., Phil. Trans. 212. pp. 27–66, April 18, 1913.)—A detailed analysis is given of the design of a large cassegrain reflector, 40-in. aperture, equivalent focal length 508 in., with special means of correcting the errors of the ordinary type, and without employing any curves and angles outside those that are already known to work well. This is done by introducing three separated lenses, made of the same glass so as to permit of the total elimination of chromatic aberration. The usual convex reversing mirror is replaced by a weak convexo-concave lens silvered at the back, and about two-thirds of the way between this and the surface of the great mirror is placed a system called the corrector, consisting of a pair of nearly equal but opposite focal lengths, of which the first is double concave, with the lesser curvature first, and the latter nearly plano-convex. All the surfaces are spherical except that of the great mirror, which is intermediate between the sphere and paraboloid. The calculations indicate that with the proposed arrangement spherical aberration, coma, and curvature of field would be completely insensible, and that stars would be represented by strictly circular images of diam. 0·56″ (arc), at a distance of 30′ (arc) from the centre of field, and of 2·25″ at 1 degree distance. C. P. B.

1640. *New Type of Kinematograph Camera.* **K. Proszynski.** (Photographic Journ. 53. pp. 99–110, March, 1913.)—Dealing first with the principles governing the production of kinematograph effects, chiefly with regard to the elimination of flicker, the article includes a detailed description, with illustrations, of a new type of kinematograph camera, which may be used like a hand-camera, without any supporting stand. To obviate any effect of vibration the front of the camera contains a powerful gyrostatic wheel, thereby keeping the camera very steady in any desired position. The motive power for driving the film is obtained from a set of cylinders containing compressed air, which are fitted in the back of the camera. These supply power to an efficient air motor which runs the film and shutter mechanism. Excellent results were demonstrated at the time of reading of the paper before the Royal Photographic Society. C. P. B.

1641. *Selective Absorption by Coloured Flames.* **R. Ladenburg** and **F. Reiche.** (Comptes Rendus, 157. pp. 279–281, July 28, 1913. Ann. d. Physik, 42. 1. pp. 181–209, Aug. 26, 1913.)—Gouy found that the absorption by a coloured flame, of rays similar to those which it emits is far from being complete, and after taking measurements he found that the brightness of the rays could be calculated as a function of the product of the thickness of the gaseous zone and the density of the metallic vapours. The present authors give a comparison of these results with data furnished by the electronic theory of dispersion, according to which the absorption of a homogeneous vapour in a narrow region of the spectrum is caused by resonance centres characterised by their number per cm.^{3}, their resonance frequency, the mass, charge, and coefficient of decay. According to Lorentz, the equations deduced retain the same values if, in place of a real decay, the regular oscillations are disturbed from time to time by impacts between the molecules. The authors find their theoretical deductions to be in accord with Gouy's measurements for different coloured flames, and give curves to illustrate this agreement. If the intensity of the rays is examined from the standpoint of Doppler's principle as developed by Rayleigh and not on the electronic dispersion theory, the results disagree with Gouy's experiments. Hence the latter theory appears to offer the correct explanation. H. H. Ho.

1642. *Refraction and Dispersion of the Halogens, Halogen Acids, Ozone, Steam, Oxides of Nitrogen, and Ammonia.* **C. and M. Cuthbertson.** (Roy. Soc., Phil. Trans. 212. pp. 1–26, April 4, 1918.)—The mean results for the refractivity (at $\lambda = 5461$ unless otherwise stated) of the gases are :—

Chlorine	0·000784	HI	0·0009258
Bromine	0·001157 at $\lambda = 6438$	Steam	0·0002527
Iodine	0·00210 at $\lambda = 6438$	Ammonia	0·0003786
HCl	0·000448	NO	0·0002955
HBr	0·0006149		

It is concluded that the refractive index of pure ozone for the mercury green line is $\mu = 1·00052$. This result is remarkable. For the refractivity of oxygen is 0·0002717, and if the third atom of oxygen on joining the molecule had the same refractive effect as in the normal gas we should expect a refractivity $(\mu - 1)\ 10^7$ of $\frac{3}{2} \times 2717 = 407·5$. The experimental value 520 is very largely in excess of this, and indicates the existence of interesting peculiarities in the molecule which may probably be ascribed to the linkage. [See also Abstract No. 1130 (1918).] L. H. W.

1643. *Law of Blackening of Photographic Dry Plates.* **E. Kron.** (Ann. d. Physik, 41. 4. pp. 751–758, July 17, 1918.)—The quantity of silver bromide which is altered by light is designated the "latent blackening," and it follows from these experiments that it must give different kinds of latent image in the layer, *e.g.* when two fields differently lighted give equal blackening with one kind of development but not with another; so it is proved that the strength of the latent image cannot be defined by a single number, but is dependent on at least two variables. This dependence of the course of the curve of constant blackening on the method of developing is a further difficulty in the way of the exposure-time relationship as a principle of photographic photometric measurement. A. E. G.

1644. *Film Distortions on Small Photographic Plates.* **F. E. Ross.** (Science, 37. p. 647, April 25, 1918. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—By means of a reseau, tests were made of the film distortions on the small photographic plates used in the photographic zenith tube at Gaithersburg, Md. Air-dried plates showed large irregular distortions, while plates first soaked in alcohol before drying showed much less disturbance. The distortions were found to disappear when the plates were measured wet. C. P. B.

1645. *Photographic Sensitising by Blood Pigments.* **J. M. Eder.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 189–198, Jan., 1913.)—The blood pigments show several characteristic and distinct absorption bands in the visible spectrum, and the present experiments are designed to prove that these pigments behave like other natural colouring matters as photographic sensitisers. The blood pigments are prepared from the red blood corpuscles of a horse, and are used in weak alkaline solutions in concentrations 1 : 100 to 1 : 1000. The plates, sensitised by bromide of silver gelatine, are kept in a bath in complete darkness for 5 mins. and then quickly dried by means of a strong ventilator. It is found that with oxyhæmoglobin and hæmin no sensitising action could be proved, but with hæmatoporphyrin feeble sensitised bands appear. In this case there are two sensitised bands with maxima at $\lambda 680\,\mu\mu$ and $\lambda 580\,\mu\mu$, while a third maximum occurs at $\lambda 555\,\mu\mu$. The absorption spectrum of the hæmatoporphyrin solution is compared with the sensitised bands produced by it. The action appears to extend from $\lambda 650$ to $500\,\mu\mu$. The validity of the law of sensitising action with respect to the connection between absorption and sensitising, together with the usual small displacement of the maxima of sensitising action towards the red side of the spectrum, is proved for this new sensitiser of animal origin. A. E. G.

1646. *Luminous Efficiency and Colour Index of Black Body.* **H. N. Russell.** (Science, 37. p. 646, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—The curves of spectral sensitiveness given by Parkhurst in the "Yerkes Actinometry" make it possible to compute the luminous efficiency of a body radiating according to Planck's law at any temperature. Some provisional results are included.

C. P. B.

1647. *Experimental Determination of the Luminous Energy absorbed in a Photochemical Reaction.* **A. Tian.** (Comptes Rendus, 156. pp. 1879–1881, June 23, 1913.)—The following arrangement is employed for the measurement of the luminous energy effecting a photochemical change. A thermopile with blackened faces is connected with a galvanometer, the front face being illuminated by the source of light to be used in the photochemical experiments, while the back face can also be illuminated, preferably by the same source of light adjustable by means of a diaphragm. Before the first face is now placed the reaction cell, either empty or containing solvent according as a gaseous or liquid medium is to be used. The illumination on the other face is then varied by regulation of the diaphragm so as to bring the galvanometer reading to zero; this equilibrium position is independent of accidental variations of the source of light when the latter illuminates both faces of the pile. The system to be studied is next introduced, either as gas or as dilute solution, into the cell, the galvanometer reading being proportional to the magnitude to be measured. The values thus obtained may be rendered absolute by subsequent illumination of the front face of the pile by means of a source of known total radiation (a black body, Hefner lamp, etc.) placed at a definite distance, the energy absorbed per sec. for a deviation of 1 mm. on the galvanometer scale being thus measured. Application of this procedure to the photochemical decomposition of hydrogen peroxide shows that no proportionality exists between the amount of chemical action and the quantity of energy absorbed, even when light free from infra-red radiations is used.

T. H. P.

1648. *Luminous Efficiency throughout the Visible Spectrum.* **R. A. Houston.** (Phil. Mag. 25. pp. 715–722, May, 1913.)—The author describes experiments on fifty different observers from whose results luminosity curves throughout the visible spectrum are derived. These were obtained for illuminations of ½ and 1/600th of a candle-metre respectively, and are plotted on the same diagram as the energy curve. By dividing the luminosity ordinates by the corresponding values for the energy, a curve of luminous efficiency can be obtained. The max. efficiency was found to be near 0·502 μ in the case of the ¼ candle-metre illumination, and near 0·466 μ with the 1/600th candle-metre illumination. All the observers had normal colour vision, and tests on the women students gave substantially the same results as those on the men students. J. S. D.

1649. *Conditions necessary in order that Pictures may appear True to Nature.* **A. Gleichen.** (Translated and simplified by G. L. Johnson. Photographic Journ. 53. pp. 183–194, May, 1913.)—A summary of the optical laws relating to the focal lengths and apertures which must be used, the degree of subsequent enlargement necessary, and the distances from which the finished pictures must be viewed, in order that they may appear approximately true to nature. L. H. W.

1650. *Preservation of Silver Mirrors.* **L. Bell.** (Electrical World, 61. pp. 1084–1085, May 24, 1913.)—An account is given of the method proposed by Perot for preserving the reflecting power of silvered mirrors [Abstract No. 21 (1910)]. A solution of collodion is poured over the surface, which is then placed in a vertical position to drain. Two mirrors were prepared, having when fresh a coefficient of about 85 %. One was exposed for 15 weeks without treatment, the other for the same time after being coated with the varnish. The coefficients of reflection were then found to be 39·8 % and 70·2 % respectively. It was found that the definition for critical optical work was not deteriorated. Mention is also made of the nickel mirrors suggested by Wood [Abstract No. 298 (1912)]. C. P. B.

1651. *Spherical Aberrations in Objectives.* **L. Dunoyer.** (Journ. de Physique, 3. Ser. 5. pp. 468–486, June, 1913.)—Discusses the question of lenses of minimum aberration. L. H. W.

1652. *Rotatory Dispersive Power of Organic Compounds.* Part I. **T. M. Lowry.** Part II. **T. M. Lowry** and **T. W. Dickson.** (Chem. Soc., Journ. 103. pp. 1062–1075, June, 1913.)—Measurements made on a number of organic compounds with rays of eight different wave-lengths lead to the following conclusions:—(1) The rotatory dispersion of a large number of simple organic compounds may be expressed by the formula, $\alpha = k/(\lambda^2 - \lambda_0^2)$, where k is the "rotation constant" and λ_0^2 the "dispersion constant" of the substance. (2) The "rotation constant" k is numerically equal to the "absolute rotatory power," α_0, which represents the rotatory power of the substance for a wave-length λ such that $\lambda^2 - \lambda_0^2 = 1$. If λ is measured in microns, this wave-length is a little greater than 1 μ or 10,000 Ångström units. (3) The "dispersive power" of a substance is conveniently measured by a unit numerically equal to 100 λ_0^2. The magnetic dispersive power of the simpler alcohols is about 2 of these units, whilst that of carbon disulphide is 4·8 units. (4) The formula given above can be applied both to magnetic and to natural rotatory powers. (5) The rotatory-dispersion curves for normal substances may be plotted out as simple rectangular hyperbolæ against the squares of the wave-lengths, or appear as straight lines if the reciprocals of the rotatory powers are plotted. T. H. P.

1653. *Rotatory Dispersive Power of Organic Compounds.* Part III. *Measurement of Magnetic Rotatory Dispersion.* **T. M. Lowry.** (Chem. Soc., Journ. 103. pp. 1322–1331, July, 1913.)—Descriptions are given of the apparatus and methods employed in the measurement of magnetic rotatory power [see preceding Abstract]. The magnet used was a modification of the one designed by Mather for Perkin's classical experiments and was arranged to give substantial uniformity of the strength of field in the region containing the liquids under examination. T. H. P.

1654. *Applications of Polarised Light.* **T. M. Lowry.** (Nature, 91. pp. 542–546, July 24, 1913. Discourse delivered at the Royal Inst., April 18, 1913.)

1655. *Enhanced Lines of Titanium in Electric Furnace Spectra.* **A. S. King.** (Astrophys. Journ. 37. pp. 119–129, March, 1913.)—In general enhanced lines of metallic elements are difficult to obtain in electric furnace spectra; for a few elements they appear in the arc under special conditions [see Abstracts Nos. 60 (1909), 1524 (1912)]. By forcing the temperature of the furnace it has now been possible to obtain the enhanced lines there also, and, incidentally, they have been obtained with remarkable relative intensity owing to a breakdown of the resistance tube, thereby giving an arc inside a highly heated cavity. The enhanced lines appear to occur right across the heated cavity, while the ordinary arc lines are strongest near the walls of the tube. Thus the enhanced lines show a distinct lack of dependence upon either temperature-difference or potential-fall. An additional effect of considerable importance with regard to the determination of wave-lengths is the dissymmetry of the lines, especially when reversed; the red component is usually much stronger than that to the violet, and this would materially affect the setting on the lines. C. P. B.

1656. *Extension of Spectrum of Hydrogen.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 73. pp. 382–385, March, 1913.)—The discovery by Fowler of a new ultra-violet series tending to the same limit as the principal series suggests a peculiarity in that no other element is at present known to give a second principal series of this type. In the present paper additional series formulæ are calculated and the resulting lines are compared with the spectra of Wolf-Rayet stars as being the most authoritative spectrum at present known to show the second hydrogen spectrum. It seems probable from the discussion that all the lines given by the formula $\lambda = \lambda_0 m^2/(m^2 - p^2)$, where m and p take integral values, are included in the astrophysical spectrum of hydrogen. In particular, this view suggests a very probable origin for the lines λλ5693, 4466, 4634, 4596, which are associated with unusual brightness of the sharp series of hydrogen. C. P. B.

1657. *Arc Spectrum of Tellurium.* **H. S. Uhler** and **R. A. Patterson.** (Amer. Journ. Sci. 36. pp. 135–140, Aug., 1913.)—The object of the research here dealt with was to determine the lines belonging to the arc spectrum of tellurium and to measure their wave-lengths in terms of the interferometer standards. Fifteen lines have been identified, all in the ultra-violet, ranging from λ3175·130 to λ2081·8, and all have been observed in the spark spectrum by other investigators. The lines λ3175·130 and λ2769·658 were differentiated from the neighbouring lines λ3175·044 and λ2769·939 of tin and antimony respectively. The arc used in the earlier experiments was formed in a specially constructed brass cylinder through which a current of CO_2 was kept flowing, but difficulty was experienced in maintaining the arc. Later, using larger quantities of the metal and working in air in the usual way, it was found that an arc could be maintained by putting lumps of the metal in a shallow hole in the lower (positive) graphite electrode, using another graphite electrode directly above. The arc is intensely white and shows the various arc-regions (core, mantle, etc.) very clearly. The research is being continued. A. W.

1658. *Energy-distribution in Spectra of Platinum, Palladium, and Tantalum.* **G. V. McCauley.** (Astrophys. Journ. 37. pp. 164–182, April, 1913.)—A detailed analysis is presented of a series of determinations of the energy spectra of the three metals for temperatures ranging from 1000° abs. to their respective melting-points. The assumed laws of metallic radiation were tested and found inadequate to express the emission of the metals in question. They acquired a minimum reflecting power in the early infra-red, becoming more marked at high temperatures. The dependence of reflecting power upon absolute temperature was shown to be similar for all three metals in the infra-red. In the visible spectrum, however, this dependence was found to be different for the different metals. No direct relation was found to exist between atomic weight and wave-length of max. emission. C. P. B.

1659. *Relative Intensity of Prismatic and Grating Spectra.* **J. S. Plaskett.** (Science, 37. p. 645, April 25, 1913. Abstract of paper read before the Astronom. and Astrophys. Soc. of America.)—Comparisons were made between the results given by grating and prism spectrographs having the same dispersion at H_γ. The chief defect of prismatic trains is the absorption by the prisms. A diffraction star spectrograph would probably be of value for the ultra-violet, and for the red, where prismatic spectra are specially compressed. C. P. B.

1660. *Damping of Series Spectrum Lines.* **C. Schaefer.** (Ann. d. Physik, 41. 4. pp. 866–870, July 17, 1913.)—A further development of theory given previously [Abstract No. 1267 (1910)]. It can be shown that the number of emissive particles for the lines of a spectrum series must decrease with increasing order number. This is confirmed by the results of Bevan [Abstract No. 869 (1911)] and Ladenburg [Abstract No. 1355 (1912)]. Mathematical treatment shows further that all the lines of a spectrum series are equally damped. Ladenburg's work for the Na lines λ5890 and λ3302 supports this conclusion. A. W.

1661. *Nitrogen Spectrum.* **M. Hamy.** (Comptes Rendus, 157. pp. 253–257, July 28, 1913.)—The explanation of the width of the lines emitted by rarefied gases, based on the application of the Doppler-Fizeau principle to the emissive centres, supposed to follow the laws of the kinetic theory of gases, has recently been the object of experimental verification on the part of Buisson and Fabry. If a gas is sufficiently rarefied so that the effect of impacts of the moving particles may be neglected, theory shows that δ is given by the formula $\delta = 0{\cdot}61\lambda\, 10^6 \sqrt{(m/T)}$, where m is the atomic mass of the gas and T its absolute temperature. This, or an equivalent expression, is in perfect agreement with the results of Buisson and Fabry, and also those of Michelson for the cadmium lines. The question arises as to whether this formula can be applied to band spectra as well as to line spectra. Using the positive band spectrum of pure nitrogen, it was found that the radiations, in the region considered (λ4400 to λ4100) give visible fringes with large path-differences. Increasing the path-difference gradually 5 mm. at a time, it was found that the fringes disappeared between 50 and 55 mm. The same values were found when a field of 15,000 gauss was applied to the discharge tube. The tube was used in a water-bath at a temperature of 20° C., but the tube itself was probably at a slightly higher temperature. Taking $\lambda = 426 \times 10^{-6}$ mm., $m = 14{\cdot}01$, the formula gives $\delta/2 = 56{\cdot}8$ mm., a value slightly higher than that found experimentally. The difference is most probably due to the experimental errors, and so it can be concluded that the law as regards the width of the lines applies not only to line spectra, but equally as well to the lines composing the positive band spectrum of nitrogen. A. W.

1662. *Use of Interferometer for Study of Band Spectra.* **R. W. Wood.** (Phil. Mag. 26. pp. 176–179, July, 1913. Phys. Zeitschr. 14. pp. 681–683, Aug. 1, 1913.)—The author has previously drawn attention to peculiar geometrical arrangements of the Fabry and Perot interference fringes exhibited in photographs of the titanium spectrum made by Pfund. It was then shown that the existence of a symmetrical pattern in such a photograph indicated that the lines were spaced according to some mathematical law, and it was suggested that in this way regularities might be found in very complicated line spectra [see Phys. Zeit. 8. p. 607, 1907]. The bright and dark bands which form the patterns appear to be of a type of interference fringes hitherto undescribed, though they are of the same nature as the shadow bands which appear when any simple periodic structure is viewed through a similar superposed structure. By their aid we can show periodic discontinuities in a spectrum which are beyond the resolving powers of the spectroscope. The manner in which the bands are formed is as follows: Using the carbon arc as the source of light, and focussing the image of the circular ring system formed by passing the light through a Fabry and Perot interferometer upon the slit of a spectroscope, we find the continuous spectrum traversed by vertical dark arcs, convex towards the red end, which are the loci of wave-lengths refused transmission through the half-silvered plates of the interferometer. If the centre of the ring system is at the centre of the slit, the portions of the slit above and below the centre are illuminated by rays which have traversed the air-film between the plates in an oblique direction, and have in consequence a smaller path-difference, the formula for the path-difference being $e = 2T\cos\theta$, in which T is the thickness of the film, and θ the angle which the rays make with the normal. As the plates of the interferometer are separated the dark arcs become narrower and more numerous, until finally the spectroscope is unable to resolve them. If now in addition to the continuous spectrum we have a bright-line spectrum, the lines will cut across the arcs, the light being absent in the line at each point of intersection. These dark spots in the spectrum lines are the cross-sections of the circular interference rings. Photographs of the green and blue-green bands of the Al arc, taken under the specified conditions, are reproduced, and show patterns made up of closed curves of elliptical or circular form. These always appear when the head of the band is on the side of short wave-length. If the band points the other way, the patterns are made up of curves of hyperbola form, as is shown by a photograph of the band of the carbon arc having its head at λ5165. Lines which do not properly belong to the series forming the band produce kinks in the patterns. To ascertain the effect which the law governing the spacing of the lines had upon the appearance of the bands in the spectrum, a number of imitation spectra were made by ruling lines with a dividing engine on the film of a photographic plate which had been fixed without exposure, the spacing of the lines being made to follow some definite law. When these plates were superposed on the photograph of the spectrum of a white source containing the dark arcs previously alluded to, the symmetrical bands at once appeared. A more extended study of the subject will be necessary before the method can be of much use in the study of band and line spectra. A. W.

1663. *Transmission of X-rays through Crystals.* **T. Terada.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 60–70, April, 1913.)—The paper contains a fuller account of the results of the experiments on the visual observation of the patterns produced on a fluorescent screen by X-rays reflected from or transmitted through a crystal [Abstract No. 1160 (1913)]. The spots formed by reflected beams are all of elongated shape, the length being nearly equal to the diam. of the undeflected spot. The breadths of the spots are not necessarily greater for thicker crystal plates than for thinner ones. For example, with a plate of alum, 7 mm. thick, the breadth is decidedly smaller than with a plate of rock-salt of 3 mm. thickness. The most interesting feature of the visual observation consists in the motion of the spots which is caused by the rotation of crystals. On rotating the crystal about an axis, the arrangement on circular cones of the reflected beams becomes strikingly conspicuous. One elliptical system of spots after another appears and disappears on the screen. The spots on some ellipses are very faint, while those on others are very bright. The results further show clearly that the appearance of the pattern in any position is closely connected with those directions in the crystals which are crystallographically conspicuous and this method of finding the zonal axes of crystals may be important for practical crystallography. The author works out the method of reconstructing Laue's photograms and of explaining the shape of the spots in a similar way to W. L. Bragg [Abstract No. 989 (1913)]. E. M.

1664. *X-rays and Crystals.* **E. Hupka.** (Deutsch. Phys. Gesell., Verh. 15. 9. pp. 369–372, May 15, 1913.)—The paper contains photographs showing that the effects due to X-rays falling on a crystal (quartz) are similar to those produced by white light falling on a suitably crossed grating. E. M.

1665. *Reflection of X-rays and Related Phenomena.* **M. de Broglie** and **F. A. Lindemann.** (Comptes Rendus, 156. pp. 1461–1463, May 13, *Erratum*, p. 1642, May 26, 1913. Nature, 91. p. 295, May 22, 1913.)—The paper discusses the effects produced on a photographic plate by X-rays reflected from the face of a crystal. In addition to the well-known reflection the images are often striated by parallel fringes [Abstract No. 1156 (1913)] due, according to Hupka [Abstract No. 1162 (1913)], to rays reflected at successive layers parallel to the surface layer of the crystal. Secondly, very strong marked bands are often observed which must probably be attributed to invisible cracks along the planes of cleavage in the crystal. In discussion of the general theory the authors further point out that reflection on some crystals, *e.g.* the base of a prism of phosgenite $(PbCl_2)CO_3$, appears to show all the spots a two-dimensional grating would lead one to expect, *i.e.* only the surface layer appears to come into play. The examination of a series of crystals of the regular system confirms the consequence of all theories and the experiments of various physicists, that the figures obtained must depend only on the position of the plate and the crystal with respect to the primary beam. It appears that it may be taken as a general rule that those crystals composed of elements of lower atomic weight reflect better than those containing heavier atoms. The relative intensity of different spots varies in

different crystals, probably according to the distribution of energy amongst the different wave-lengths in the primary beam. But even in one and the same crystal the intensity of different spots varies according to its position.
E. M.

1666. *Diffraction of Electric Waves by a Crystal.* **L. S. Ornstein.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1271–1281, July 15, 1913.)—Develops mathematically the theory put forward by W. L. Bragg of the phenomena dealt with by Friedrich, Knipping and Laue [see Abstracts Nos. 989 and 1153 (1913)]. Photographs by Haga are also provisionally noted. These are obtained from rock-salt, ZnS, CaF_2, topaz, and mica.
E. H. B.

1667. *Theory of X-ray Interference.* **P. P. Ewald.** (Phys. Zeitschr. 14. pp. 465–472, June 1, 1913.)—Gives a theory of the interference of X-rays in crystals which resembles that of Laue, but applies to an infinite crystal. The formula for the intensity of the reflected ray assumes a sufficient continuity in the spectrum distribution of the incident radiation, and the strong and almost monochromatic radiation of the antikathode discovered by Bragg must be dealt with separately. The wave-length is of the order of $\frac{1}{10}$ of the grating element.
E. E. F.

1668. *X-rays and Crystals.* I. **M. de Broglie.** (Le Radium, 10. pp. 186–195, June, and pp. 245–249, Aug., 1913.)—A collected account of the author's work on the subject [see Abstracts Nos. 1154, 1155, 1156 (1913)]. A magnetic field of 10,000 gauss had no effect on the patterns obtained with either rock-salt or magnetite. In the paper eleven good reproductions are given of the photographs obtained with various crystals and also with mercury light and crossed gratings. The results show clearly the connection between the theories of the two effects. In some of the photographs the fringes on the spots are noticeable. Hupka explains these fringes as due to interference between the rays reflected successively from a series of planes parallel to the surface of the crystal owing to the incident X-rays being slightly divergent. In a later paper the author hopes to consider evidence as to the wave-length of the rays used.
E. M.

1669. *Experiments on Polarised Röntgen Radiation.* **J. C. Chapman.** (Phil. Mag. 25. pp. 792–802, June, 1913.)—Up to the present all experiments on the rotation of the plane of polarisation have been made using light of a wave-length of the order of that found in the visible spectrum. The results indicate that the magnitude of the rotation in quartz and other active substances varies inversely as some power of the wave-length. On the assumption that X-radiation is merely light of exceptionally short wave-length, it seemed possible that a great rotation of the plane of polarisation might be obtained under suitable conditions. The experiments described were undertaken to test this point. Polarised X-radiation was obtained by suitable orientation of the kathode of an X-ray bulb and a secondary radiator as in the original experiments of Barkla. Iron in a magnetised state, quartz, and active sugar solution were examined, but with negative results in all cases. Iron was shown to absorb a polarised beam of X-rays to the same extent whether magnetised or unmagnetised. The experiments also show that the absorption by a plate of tourmaline is independent of the direction of the optic axis. E. M.

1670. *International Radium Standard.* **E. Haschek** and **O. Hönigschmid.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2119–2125, Dec., 1912.)—

The authors have examined the Ba-content of the radium used by Hönigschmid [Abstract No. 759 (1912)] in his determination of the atomic weight (value 225·95). The spectrum of the salt showed no Ba lines, and from observations of the amount of added Ba necessary to show the lines the authors conclude that the original salt used by Hönigschmid did not contain more than 0·002 % Ba. E. M.

1671. *Alpha-ray Ionisation.* **H. N. McCoy.** (Phys. Rev. 1. Ser. 2. pp. 398–400, May, 1913.)—A formula is developed for the α-ray activity of a layer of a radio-active solid as a function of its thickness. It is assumed that the air range of an α-particle is diminished in its passage through the solid by an amount directly proportional to the distance it travels in the solid before emerging, and that the ionisation produced is proportional to the 2/3 power of the distance the α-particle then travels in air. The theoretical curve for the rise in activity with increasing thickness of the layer is almost the same as an exponential curve, although the fundamental equations are entirely different. In the following table the first row gives the thickness (a) of active material expressed as a fraction of the thickness necessary for the max. activity. The second row (A) gives the activity expressed in terms of the max. activity.

x	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
A	0·000	0·284	0·497	0·659	0·780	0·869	0·930	0·967	0·989	0·998	1·000

It is shown that the activity of a film just thick enough to give the max. activity is 0·8 of the activity of the same material spread in a very thin film. The author has also made experiments on U_3O_8 and finds results in good agreement with theory. The weight per unit area just necessary to give the maximum UrII activity is found to be 0·01064 gm. E. M.

1672. *Alpha-rays from Thick Layers.* **E. v. Schweidler.** (Phys. Zeitschr. 14. pp. 505–507, June 15, 1913.)—Calculates the number of α-particles emitted in unit time from unit surface of a plane-parallel plate of thickness h, if the range is R and the number emitted by unit volume is N. The result is $n = \frac{1}{2}Nh(1 - h/2R)$ for $h \leqq R$ and $n = NR/4$ for $h \geqq R$. The author also finds the law of distribution of the "residual ranges," *i.e.* the range which the particle would have if the absorptions within and outside the plate were the same. He also obtains expressions for the ionisation outside the plate (which, for $h > R$, is proportional to the 5/3rd power of R). and for the radiation of a radio-active plate through an absorbing plate. [*Errata*, Ibid. p. 728, Aug. 1, 1913.] E. E. F.

1673. *Number of Ions produced by an α-Particle from Polonium.* **R. Girard.** (Le Radium, 10. pp. 195–198, June, 1913.)—The method of experiment was to measure the saturation current (I) from a silver plate coated with Po and to count the number (N) of α-particles by a scintillation method. The number of ions (X) produced per α-particle is then equal to $X = I/Ne$. The author finds $X = 116{,}000$ (e assumed $= 4{\cdot}17 \times 10^{-10}$). This is much smaller than Geiger's value 162,000 [Abstract No. 1547 (1909)] or Taylor's value 164,000 [Abstract No. 1086 (1912)]. The difference appears to arise mainly in the method of measurement since the α-particles ejected nearly along the plane of the source will be partly absorbed. For measurements of the activities of films, therefore, it would appear better to use the author's value. E. M.

1674. *Active Radiation of Potassium.* **H. Thirring.** (Phys. Zeitschr. 14. pp. 406–408, May 1, 1913.)—Explains the spontaneous negative charge of potassium observed by J. W. Woodrow [Abstract No. 111 (1913)] as due to a pure Volta-effect. When K and Pt are enclosed opposite each other in a light-tight envelope, they represent a galvanic cell of high internal resistance, since the gas, slightly ionised by the K, behaves like an electrolyte. The e.m.f. is high, as K and Pt are at opposite ends of the Volta series. If Hg is substituted for K, the current should be only about $\frac{1}{40}$th, on account of the small contact e.m.f. Hg-Pt, and still smaller on account of the feeble ionisation of the gas. The author finds no difference in the e.m.f. when the gas is artificially ionised, and concludes that the spontaneous charge is not due to the emission of particles. The e.m.f. attained is about 2·8 volts, and the internal resistance of the order of 10^{12} ohms. E. E. F.

1675. *Analysis of γ-Rays from Radium B and Radium C.* **E. Rutherford** and **H. Richardson.** (Phil. Mag. 25. pp. 722–734, May, 1913.)—Gray has shown that the γ-rays emitted from RaE are able to excite the characteristic X-radiations of certain elements, thus proving the similarity of γ- and X-rays. Rutherford later put forward the view that the γ-rays from radio-active substances are to be regarded as the characteristic radiations of the respective elements themselves, set up by the escape of α- or β-rays from them. The consideration further suggests that several types of γ-radiation may be emitted from the same radio-active product and that each type of characteristic radiation should be absorbed according to an exponential law by an absorbing substance of low atomic weight like aluminium. The present experiments were undertaken to test this point. The source, consisting of either RaEm in a thin-walled glass tube or pure RaC deposited on nickel, was placed in a very strong magnetic field. The electroscope was lined with Al except for a wall of very thin mica, and contained methyl iodide vapour so as to multiply up the ionisation due to soft radiation without appreciably increasing that due to hard radiation. The ionisation curve was determined by interposing sheets of metal, and it was found that in the case of Al the curve could be built up by assuming the presence of various radiations each absorbed exponentially. With lead irregular absorption curves were obtained. With RaC deposited on nickel a soft γ-radiation excited in the nickel by the α-rays was observed, this being shown by experiments in which the RaC was deposited on silver. The results are as follows :—

	Absorption Coefficient in Aluminium.	Mass Absorption Coefficient in Aluminium.	Absorption Coefficient in Lead.
Radium B............	280 ? 40 (cm.)$^{-1}$ 0·51 „	. . . . . . 14·7 (cm.)$^{-1}$ 0·188 „	Varying from 11 to 2·8 (cm.)$^{-1}$.
Radium C............	0·115 „	0·0424 „	0·50 (cm.)$^{-1}$ after traversing 1 cm. of lead.

The soft radiation of RaB ($\mu/D = 14·7$) corresponds closely to that of Barkla's series L, while the radiation of RaC corresponds to that of series K.

An examination of the γ-rays from all radio-active elements is in progress. E. M.

1676. *Interference Phenomena with Gamma Rays.* **A. N. Shaw.** (Phil. Mag. 26. pp. 190–194, July, 1913.)—The experiments aimed at the observation with γ-rays of interference phenomena similar to those of various experimenters with X-rays. Mica was used at almost grazing incidence, and exposures of about a month with 15 mgm. $RaBr_2$ were given. The photographs show a series of lines besides the main circular image. The effects were observed in one of the directions in which the more intense spots were obtained with very hard X-rays, and no perceptible effect was observed in the direction in which soft X-rays give their strongest reflection. With soft X-rays the "spot" due to reflection at the cleavage planes appears most prominent. With hard X-rays and with γ-rays other spots spring into much greater prominence, presumably by "reflection" from other planes. The author considers that the wave-length of the γ-rays used is between 10 and 100 times smaller than that of the hardest Röntgen radiations. E. M.

1677. *Velocities of δ-Rays.* **H. A. Bumstead.** (Amer. Journ. Sci. 36. pp. 91–108, Aug., 1913.)—A continuation of previous experiments [Abstract No. 1862 (1912), etc.]. The observations were made by allowing the α-rays from polonium to fall on metal surfaces under various conditions in a very high vacuum. The main part of the investigation deals with high-speed δ-rays. It is shown that when α-rays fall on a metal plate, electrons are emitted with velocities varying continually from a very small value up to $2{\cdot}7 \times 10^9$ cm./sec. which corresponds to a fall of potential of 2000 volts. It is proposed to include under the name "δ-rays" all the electrons which owe their origin to the direct action of the α-rays—the swifter ones as well as the slower ones previously known. When the swifter δ-rays fall upon a solid it emits electrons of slow speed which, in the present paper, are referred to as tertiary electrons. Their number is considerably greater than the δ-rays which produce them. The existence of the tertiary electrons makes it difficult to determine with accuracy the distribution in velocity of the δ-rays. A large number of tertiary electrons come from the source of δ-rays itself, and their presence in the beam of δ-rays makes it impossible to draw valid conclusions as to the number of true δ-electrons of slow speed (less than 10 or 20 volts). The distribution in velocity of the δ-rays between 20 and 1200 volts has also been determined. Between 80 and 500 volts the results are approximately represented by an equation of the form $yx^n = c$, where y is the number of electrons whose kinetic energy is equal to or greater than x, and $n = 0{\cdot}75$.

Evidence is given for the view that, in addition to the δ-rays, positive ions are also produced when α-rays impinge upon a metal in a very high vacuum; these ions appear to come from the layer of absorbed gas upon the metal. By maintaining the vacuum for several days the current carried by these ions may be reduced to a small value—from 5 to 10 per cent. of that carried by the α-rays themselves. E. M.

1678. *Ionisation in Closed Vessels.* **J. J. Rey.** (Le Radium, 10. pp. 137–141, April, 1913.)—After closing the vessel the ionisation was found to decrease to a minimum after about one month, the decrease being shown to be due to the decay of radium emanation. If non-filtered air was used the ionisation first increased for about 4 days, due to dust gradually settling on the walls of the vessel and thus preventing the recombination of ions due to the presence of large nuclei. With regard to variations in the ionisation the results show that when observations were made over $\frac{1}{10}$-hour intervals the average fluctuations were 2 % ; over $\frac{1}{100}$-hour, 5 % ; and over $\frac{1}{400}$-hour, 7 %. Observations were also made at reduced pressures : a peculiar effect was noticed, in that with decreasing pressure the ionisation first increased slightly to a maximum at about 40 cm. Hg. This is presumed to be due to very easily absorbed radiations emitted by the walls of the vessel.

E. M.

1679. *Bragg Ionisation Curves.* **P. Bianu.** (Le Radium, 10. pp. 122–125, April, 1918.)—The first experiments show that the range of the α-particles of polonium in air is inversely proportional to the pressure to less than 1 % between pressures of 8 cm. and 86 cm. Hg. Further, the total number of ions produced by the α-particle for complete absorption is shown to be the same between these pressures. The author has also investigated the shape of the ionisation curve when the α-particles have traversed sheets of metal foil, and the results show that the position of max. ionisation is altered by a greater amount than the end of the range. The following are the values of the reduction of range at 26·25 cm. pressure in air by thickness 1 μ : Al, 0·45 ; Ag, 0·91 ; Au, 1·25 cm. Under the same conditions the shift of the maximum of the ionisation curve relative to the end of the range is found to be Al, 0·08 ; Ag, 0·14 ; Au, 0·8 cm. E. M.

1680. *Existence of Uranium Y.* **A. Fleck.** (Phil. Mag. 25. pp. 710–712, May, 1918.)—The author has repeated the experiments of Antonoff [Abstract No. 1684 (1911)] on a product UrY, supposed to be a small branch product from Ur, very similar in chemical properties to UrX. No trace of the product could be found, and the author considers Antonoff's results as due to the presence of thorium in his uranium. The soft β-rays ascribed to UrY are presumed to have been due to thorium B. E. M.

1681. *Transformation Periods of Uranium and Thorium.* **H. N. McCoy.** (Phys. Rev. 1. Ser. 2. pp. 401–404, May, 1918.)—It now appears to be well established that the number of ions, N, produced by any α-particle of range R is closely proportional to $R^{2/3}$ or $N=aR^{2/3}$. The constant a may be calculated from the number of ions known to be produced by an α-particle of polonium, *i.e.* 168,000. This gives $N=6{\cdot}97\times10^4R^{2/3}$. If I is the total ionisation current in amps. of 1 gm. of a radio-active element of atomic weight M and decay constant λ it follows that—

$$\lambda(\text{sec.})=IM/NF=IM/(6{\cdot}97\times10^4R^{2/3}F),$$

where $F=96{,}600$ coulombs. This gives a method of determining λ, and thus the half-time period. Putting in the value of I for Ur $(1+2)$, viz. $4{\cdot}61\times10^{-10}$ amp., the author calculates the half-time period of UrI to be $5{\cdot}04\times10^9$ years. Rutherford and Geiger's value calculated from the number of α-particles emitted is $4{\cdot}8\times10^9$ years. For thorium the author deduces a period $1{\cdot}8\times10^{10}$ years, Rutherford and Geiger's value being $1{\cdot}31\times10^{10}$ years. E. M.

1682. *Growth of Radio-thorium from Meso-thorium2.* **J. A. Cranston.** (Phil. Mag. 25. pp. 712–715, May, 1918.)—The object of the experiment was to establish whether or not there exists an intermediate body between Meso-Th2 and Radio-Th. Additional interest is lent by the fact that Radio-Th corresponds with ionium, the parent of which is experimentally unknown. In the experiments Meso-Th was taken, and the Meso-Th2 separated out and purified by a chemical method based on its analogy with actinium. The growth of α-ray activity of the Meso-Th2 with time was observed, this growth being due to the formation of Radio-Th and subsequent products. The "rise curve" was found to agree well with that calculated on the assumption that Meso-Th2 disintegrates directly into Radio-Th with no intermediate product. The results also suggest the possibility that a few, less than 3 in 10,000, of the atoms of Meso-Th2 may disintegrate with the emission of α-particles. E. M.

1683. *Emanation in Spring Water.* **W. Hammer** and **F. Vohsen.** (Phys. Zeitschr. 14. pp. 451–454, May 15, 1913.)—Further data are given concerning Hammer's "fontactoscope" or emanation electroscope [Abstract No. 1580 (1912)]. Accurate values are obtained when the sample of water is left for 3 hours in the vessel before testing. But measurements sufficiently accurate for most purposes (3 or 4 per cent.) can be made after 15 minutes. A table is given for determining the amount of RaEm from the radio-activity of the solid deposits. E. E. F.

1684. *Radium-content of Alabama Coal.* **S. J. Lloyd** and **J. Cunningham.** (Amer. Chem. Journ. 50. pp. 47–51, July, 1913.)—The experiments were carried out by the emanation method on eleven samples from different localities. The coal was first heated to remove carbonaceous matter, and the ash then dissolved. The measurements were standardised by the emanation from Joachimstal pitchblende of known uranium-content. The average radium-content per gm. of ash was found to be $2{\cdot}15 \times 10^{-12}$ gm., and per gm. of coal $0{\cdot}166 \times 10^{-12}$ gm. A large variation in the amount of radium per gm. of ash was observed, the lowest being roughly one-fifteenth of the highest. No relation could be found between the Ra-content and the sulphur, volatile carbon, or fixed carbon-content. E. M.

1685. *Diffraction and Reflection of X-Rays.* **de Broglie.** (Comptes Rendus, 156. pp. 1753–1755, June 9, 1913.)—Discusses the theory of the effects produced when X-rays fall on crystals. E. M.

1686. *Interference Phenomena with Röntgen Rays.* **W. Friedrich, P. Knipping** and **M. Laue.** (Ann. d. Physik, 41. 5. pp. 971–988, Aug. 5, 1913. Reprinted from K. Bayer. Akad. München, Ber. pp. 303–322, 1912.)—[See Abstract No. 1153 (1913).]

1687. *Radio-activity.* **E. P. Adams.** (Amer. Inst. Elect. Engin., Proc. 32. pp. 1159–1233, May, 1913.)—A series of five lectures furnishing a comprehensive general survey of the subject. L. H. W.

1688. *Radio-activity of the Hot Springs in the Beppu Region, Bungo.* **D. Isitani** and **I. Yamakawa.** (Mathematico-Physical Soc., Tōkyō Proc. 7. pp. 32–36, March, 1913.)—[See Abstract No. 86 (1913).]

HEAT.

1689. *Thermal Expansion of Marble.* **H. Nisi.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 97–102, May, 1913.)—Rings are cut in several directions from a selected block of Carrara marble. The expansion of these between 0° and 40° C. was found by Fizeau's interferometer. The result for any specimen depends on its inclination to the plane of cleavage of the marble, a negative coefficient being found in some directions. The extreme values of the coefficient are $-0{\cdot}77 \times 10^{-6}$ and $+11{\cdot}24 \times 10^{-6}$.

P. E. S.

1690. *Melting-points, Specific Heats, and Latent Heats of Fusion of Alkaline Metals.* **E. Rengade.** (Comptes Rendus, 156. pp. 1897–1899, June 23, 1913.)—Owing to the uncertainty of some of the thermal data for the alkali metals, the author has made a series of measurements with materials carefully purified. The results are as follows :—

	Na.	K.	Rb.	Cs.
True specific heat (solid)	0·2811+ 0·000233t	0·1728+ 0·000142t	0·0802+ 0·000153t	0·0522+ 0·000137t
True specific heat (liquid)	0·330 (at 98°)	0·1422+ 0·000668t	0·0921— 0·000026t	0·0604— 0·000034t
Latent heat of fusion	27·21	14·67	6·144	3·766
Atomic heat at 0°	6·47	6·75	6·85	6·95
Atomic heat of fusion, L	625·9	573·6	524·8	500·0
Melting-point......	97·90°	63·50°	39·00°	28·45°
L/T	1·69	1·70	1·68	1·66

It will be seen that the values of the atomic heats increase slowly and regularly with the atomic weights and that the atomic heats of fusion diminish gradually, while the ratios of the atomic heats of fusion to the absolute melting-points exhibit great constancy. The high degree of purity of the metals employed is indicated by their melting-points, which are 1–2° higher than those usually accepted. T. H. P.

1691. *Relation between the Law of Compressibility of Gases and Coefficients of Expansion.* **T. Peczalski.** (Comptes Rendus, 156. pp. 1884–1886, June 23, 1913.)—It is shown mathematically that the function $vp = f$, which is not constant for true gases at constant temperature, passes through a minimum or max. value if the thermal coefficients of expansion, α, and pressure, β, are identical. The ratio α/β is a function of the pressure, so that—

$$\alpha/\beta = a - bp - cp^2 -, \text{etc.},$$

where a, b, c, etc., are functions of the temperature alone. It follows that $vp = \mathrm{A}e^{bp + cp^2/2 + dp^3/3 +, \text{etc.}}$, where A represents the value of vp when $p = 0$. In its simpler form, $vp = \mathrm{A}e^{bp + c_1p^2}$, this equation is found to be in good agreement with the experimental values for hydrogen, nitrogen, and air. T. H. P.

1692. *New Forms of the Characteristic Equation for Gases.* **T. Peczalski.** (Comptes Rendus, 157. pp. 113–115, July 15, 1913.)—The law of compressibility of gases at constant temperature [see preceding Abstract] has now been extended to cases where the temperature varies. The relation then becomes—

$$pv = \mathrm{A}e^{\int_{t_0}^{t} a_0 dt + bp + cp^2/2 + \dots}.$$

where A is a constant. The coefficients c, d, etc., being very small, may be neglected in calculations for pressures up to 50 atmos. without appreciable error. Further, Witkowski's experiments on hydrogen show that above $-104°$ the variation of b is small and may be disregarded, so that the variation of the function vp with t depends practically only on $\int a_0 dt$. The expression $\alpha/\beta = 1 - bp - cp^2 - \dots$ may be written—

$$\alpha = a_0 + a_1 p + a_2 p^2/2 + a_3 p^3/3 \dots,$$

a_0, a_1, etc., being functions of the temperature alone. The value of α being constant as regards the temperature, it follows that $vp = \mathrm{A}e^{at + bp}$, a being the coefficient of expansion and b being calculated from the data given above; this equation will represent the transformations of hydrogen between 0 and 50 atmos. and from $-100°$ to $+100°$ or even higher. If v and t are taken to be independent variables and it is assumed that—

$$\beta/\alpha = 1 - b_1/v + c_1/v^2 - \dots \quad \text{or} \quad \beta = a_0 + a'_1/v + a'_2/v^2 + \dots,$$

the characteristic equation becomes—

$$vp = \mathrm{A}e^{\int a_0 dt + b_1/v + c_1/v^2 + \dots},$$

or, if only the first two terms of the development of β/α are taken—

$$vp = \phi(t)e^{f(t) \cdot 1/v},$$

which is very similar to Dieterici's equation—

$$p(v - b) = \mathrm{RT}e^{-c/\mathrm{RT}v}.$$

T. H. P.

1693. *Catathermic Rays.* **J. A. Le Bel.** (Comptes Rendus, 157. pp. 201–203, July 21, 1913.)—The term "catathermic ray" is applied to those radiations which originate in the interior of certain substances when unequally heated. These experiments show that these rays are not only produced in metals but can be also obtained with sand, and it is further shown that ordinary walls emit a feeble radiation under the influence of temperature-changes.

A. E. G.

1694. *Relation between Geometrical Form and Vapour Pressure, Solubility, and Stability of Form.* **W. J. Jones.** (Ann. d. Physik, 41. 2. pp. 441–448, June 3, 1913.)—A strict proof of Thomson's law concerning the influence of surface curvature on the vapour pressure of liquids brought forward by von Helmholtz (Wied. Ann. 27. p. 509, 1886), who considered only the simple case of spherical drops and gave the equation, $\mathrm{RT/M} \,.\, \log_e (p_2/p_1) = 2\sigma/\rho \,.\, (1/r_2 - 1/r_1)$, where p_1 and p_2 indicate the vapour pressures of spherical drops of radii r_1 and r_2, σ is the surface tension, ρ the density of the liquid, T the absolute temperature, R the gas constant (8316×10^7 erg/temperature), and M the molecular weight of the vapour. The author proceeds to the generalisation of this law, Gibbs (Scientific Papers, 1. p. 315, 1906) having shown that with isotropic solids, just as with liquids, σ represents the work of formation of unit area of the solid-liquid or solid-gas surface. The generalised formula deduced is applied to the consideration of (1) the variation of vapour pressure and solubility with the magnitude of the particles, (2) the heat-changes accompanying changes of surface, and (3) the stability of geometrical forms.

T. H. P.

1695. *Use of Liquid Nitrogen for conveniently producing Temperatures down to* —211° C. **G. Claude.** (Comptes Rendus, 157. pp. 277–279, July 28, 1913.)—The author demonstrates the ease with which, in the absence of liquid hydrogen, it is possible to attain in a few minutes the solidification temperature of nitrogen, viz. —210° C. The principle adopted is that when a current of air is rapidly passed through a liquefied gas, this is cooled below its normal ebullition point. The process employed is more convenient, rapid, and permits the use of smaller quantities of liquid nitrogen than evaporation *in vacuo*. The liquid nitrogen is contained in a d'Arsonval-Dewar flask into which the extremity of a copper worm dips. The worm is cooled in another vessel by liquid nitrogen and traversed by a current of hydrogen, which is then bubbled through the liquid, thereby producing rapid cooling, *e.g.* —200° C. after 2 mins., — 206° C. after 6, and — 210° C. after 12 mins. Experimental conditions are given, which are simple and allow of working with an open vessel.

H. H. Ho.

1696. *On the Law of the Partition of Energy.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1175–1184, May 30, 1913.)—The author has tried to show that it is possible to account for the partition of energy in the normal spectrum with the aid of differential equations, which admit of a continuous emission and absorption of energy, and that it is therefore not necessary for the explanation of the normal spectrum to have recourse to the supposition of quanta, either of energy or of "action." For this explanation it is necessary to draw up a system of mechanics, in which a certain relation takes the place of the equation of Liouville in "classical" mechanics. In order to determine this equation the solution of a certain integral equation is required, which, however, the author has not succeeded in obtaining.

L. H. W.

1697. *Luminosity of Black Bodies at High Temperatures.* **C. Nordmann.** (Comptes Rendus, 156. pp. 664–666, March 3, 1913.)—Further application of the development of Planck's law to the investigation of stellar temperatures results in the conclusion that taking the effective temperature of Vega (α Lyræ) as 12,200° abs., the temperature of Arcturus will be about 3400° abs. with a superior limit of 3900°.

C. P. B.

1698. *Gas Thermometer as Basis for the Measurement of High Temperatures.* **F. Henning.** (Zeitschr. Elektrochem. 19. pp. 185–192, Feb. 15, 1913.)

1699. *Thermodynamical Deduction of the Law of Photo-chemical Equivalence.* **Einstein.** (Journ. de Physique, 3. Ser. 5. pp. 277–282, April, 1913. Paper read before the Soc. franç. de Physique.)

1700. *Recent Theories of Heat and Radiation.* **W. Wien.** (Washington Acad. Sci., Journ. 3. pp. 273–284, May 19, 1913.)—A general survey.

SOUND.

1701. *Range and Sharpness of Resonance under Sustained Forcing, and their Variations with Pitch.* **E. H. Barton.** (Phil. Mag. 26. pp. 111–148, July, 1913.)—Fundamental in the theory of resonance is the result that the response is fuller when the tuning between force and responding system is closer. Further, the diminution of resonance for a given mistuning depends upon the damping of the responding system. The resonance is said to be sharper when this damping is small, or, in other words, the range of resonance is greater when the damping is large. There appears, however, to be another factor affecting range of resonance, viz., the pitch or frequency of the vibrations, and, when the harmonic impressed forces are sustained, this second factor is just as fundamental and inevitable in its influence as the first. The effect of the pitch seems to have been overlooked, and the author shows that the range of resonance, which varies directly as the damping coefficient, also varies inversely as the frequency. The application of this principle extends to any cases of sustained forced vibrations, whether mechanical, acoustical, or electrical, and the object of the present paper is to sketch the necessary theory and illustrate it by a few experiments. It will be found that the principle under discussion throws light upon some apparently anomalous notes obtained on certain brass instruments. Several previous writers have shown that the character of the resonance is a function of the logarithmic decrement of the responding system, but the decrement appears to have been treated as a single quantity measuring the damping, and the possibility of changing the log. decrement, and therefore the sharpness of resonance, by a change in frequency, the damping coefficient remaining constant, seems to have escaped their attention. The mathematical theory is then developed in detail. Illustrative experiments are described which qualitatively show the dependence of resonance range on pitch as well as damping for the three cases, mechanical, acoustical, and electrical, while others yield a quantitative result in corroboration of the theory. The mechanical case was demonstrated by experiments with the double pendulum, the acoustical by Melde's experiment with constant tension and with constant number of segments, by Helmholtz's experiment of the response elicited from a stretched string by a tuning-fork, by adjustable resonators and forks, and by brass instruments, while possible electrical examples are discussed. In the latter case, which might be supposed the most complicated of all, many of the factors are entirely at the experimenter's disposal; thus, by modifying the values of the inductance, resistance, and capacity of the responding circuit, both its frequency and sharpness of resonance to suitable forcing oscillations, provided they are of sustained amplitude, may be controlled. Moreover, this can be done in a variety of ways to fulfil some other condition, such as keeping the inductance at a given value, halving the resistance, or quadrupling the capacity. The author had hoped to make some confirmatory experiments with Fleming's cymometer, but these are postponed for a more extended examination. Tables of results are given for the various experiments. Summarising his results the author states: (1) In the case of vibrations executed under sustained harmonic forcing, the sharpness of response varies directly as the frequency of the vibrations it is sought to elicit, provided the damping coefficient remains constant. (2) These relations are held to apply to any forced vibrations fulfilling the above conditions, whether mechanical, acoustical, or electrical. (3) The principle affords a valuable clue to the best arrangement of certain experiments on forced vibrations, whether of a merely qualitative nature for lecture illustrations or of a strictly quantitative character for laboratory determinations. (4) In the case of brass instruments the variation of resonance range with pitch is specially noticeable. It serves to elucidate the apparently anomalous production on certain instruments of a low note, while various other points in the theory and practice of brass instruments are also rendered clearer by the theory. (5) The strongly damped electrical oscillations usually dealt with on Fleming's cymometer lie outside the scope of the simple theory here developed for the response under sustained forcing. H. H. Ho.

1702. *Theory of Combination Tones with Strings and Membranes.* **C. Schaefer and E. Juretzka.** (Ann. d. Physik, 41. 3. pp. 581–592, June 24, 1913.)—Instead of using Helmholtz's equation, primarily applicable to a particle—

$$d^2x/dt^2 + n_0^2x + \delta x^2 = a\cos pt + b\cos qt \quad \ldots\ldots\ldots\ldots\ldots(1)$$

the authors use the following more general form—

$$\frac{d^2x}{dt^2} + n_0^2x \pm \sum \delta_{\alpha\beta}\frac{d^\alpha x}{dt^\alpha}\cdot\frac{d^\beta x}{dt^\beta} = a\cos pt + b\cos qt \quad \ldots\ldots\ldots(2)$$

where α and β are any two positive finite integers. In the special cases where $\alpha = \beta = 1$ equation (2) becomes—

$$d^2x/dt^2 + n_0^2x \pm \delta(dx/dt)^2 = a\cos pt + b\cos qt \quad \ldots\ldots\ldots\ldots(3)$$

where the vibrations occur in a medium whose *resistance is proportional to the square of the speed*. The mathematical investigation which follows shows that the behaviour of strings and membranes as regards combination tones is analogous to that of particles. E. H. B.

1703. *Wave Model.* **H. Barkhausen.** (Phys. Zeitschr. 14. pp. 620–622, July 15, 1913.)—The model consists of a large number of thin rectangular strips of tin, soldered to a thin wire traversing the central line parallel to the narrow edges. The larger and heavier the strips, the slower will a torsional wave travel along the wire. One side of the strips is coloured black and the other white, and they are all originally seen end-on. If the wire is vertical, the lower end may be free. The torsional waves correspond precisely to the modes of vibration of strings and pipes, the succession of original oscillations governing the order of the overtones. Since the damping is feeble, the oscillations are maintained for several minutes. E. E. F.

1704. *Speed of Sound in a Homogeneous Fluid.* **Ariès.** (Comptes Rendus, 157. pp. 110–112, July 15, 1913.)—Remarks on the form of the expression for the theoretical speed of propagation of sound in a homogeneous fluid. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1705. *Specific Inductive Capacity and Atomic Charges.* **F. Sanford.** (Phys. Rev. 1. Ser. 2. pp. 446–456, June, 1918.)—In this and preceding papers the author has undertaken to show that if the mobilities of ions, as calculated from electrolysis be multiplied by their respective ionic masses, numbers are obtained which are closely related to many of the physical and chemical properties of the ions. On certain assumptions these numbers become proportional to the electric charges of the ions and have been spoken of as the characteristic ionic charges. These charges have been shown to be related to all the properties of bodies which depend on cohesion or affinity. In the present paper their relation to specific inductive capacity is discussed. [See Abstract No. 510 (1918.)] E. H. B.

1706. *Electrification by X-rays.* **C. G. Bédreag.** (Comptes Rendus, 157. pp. 39–41, July 7, 1918.)—The author has made experiments on the electrification of electrodes of brass and silver exposed at low pressures to X-rays. As the pressure is decreased below about 10^{-3} mm. Hg the electrodes become charged with an increasing positive charge which is further increased when the electrodes are placed in a magnetic field. At atmospheric pressure the particular electrodes become charged negatively. E. M.

1707. *On the Approximate Solution of certain Problems relating to the Potential.* **Rayleigh.** (Phil. Mag. 26. pp. 195–199, July, 1918.)—Mathematical; supplementary to a paper with the same title published in the author's "Scientific Papers" (vol. 1, p. 272).

DISCHARGE AND OSCILLATIONS.

1708. *Energy required to Ionise an Atom.* **R. T. Beatty.** (Phil. Mag. 26. pp. 183–186, July, 1918.)—Using certain assumptions the author calculates the energy required to remove an electron from the atoms of the gases of the helium group. In each case the atom is supposed to consist of a central positive nucleus with charge ne, surrounded by inner rings with $n-2$ negative electrons, and the remaining two electrons at opposite ends of a diam. on an outer ring determining the size of the atom. Accordingly, for all purposes of calculation the atoms of the inert gases can all be represented by a central charge $2e$, and two electrons at opposite ends of a diameter, $2a$. The energy required to remove one of these electrons from the atom is given by $2e \, . \, e/a - e \, . \, e/2a = 1{\cdot}5e^2/a$. This corresponds with the energy acquired by falling through a difference of potential E, if $Ee = 1{\cdot}5e^2/a$. Using Jeans's corrected value for the radius of the He atom and Rankine's relative values of the atomic radii the following values of E are calculated: He, 19·4; Ne, 16·3; A, 11·6; Kr, 10·15; Xe, 8·65 volts respectively. These numbers agree well with the experimental values of Franck and Hertz, viz. He, 20·5; Ne, 16; A, 12. No experimental values are yet published for Kr and Xe. E. M.

1709. *Ionisation in Gases and Gaseous Mixtures by Röntgen and Corpuscular Radiations.* **C. G. Barkla** and **A. J. Philpot.** (Phil. Mag. 25. pp. 832–856, June, 1913.)—A study of the ionisation produced in gases and in mixtures of gases and vapours by corpuscular radiations and by X-radiations furnishes valuable information regarding the processes taking place during the transmission of these rays through matter. In the first experiments described characteristic X-rays from a radiator (Sn, Ag, or Ba) traversed an ionisation chamber of carbon. The ionisation current was measured, the walls then lined with thin gold-foil, and the current measured again. From these observations the ionisation due to the complete absorption of the corpuscular radiation from the gold was deduced. Experiments were made with several gases and the following values obtained for the relative total ionisation: Air, 100; H_2, 102; N_2, 98; O_2, 110; CO_2, 102; SH_2, 138; SO_2, 96; C_2H_5Br, 150; CH_3I, 148. No change of relative ionisation could be detected when different radiators were used, *i.e.* with different velocities of ionising corpuscles. The authors show that the above figures for the relative ionisations due to complete absorption of corpuscular radiation agree closely with the relative ionisations due to complete absorption of a Röntgen radiation with all its secondary radiations. Accepting as proved that all X-ray ionisation is by means of the ejected corpuscles this shows that the number of corpuscles set free in a gas by a Röntgen radiation which is completely absorbed depends little, if at all, upon the nature of the gas.

Tables are given of the ionisation coefficients for homogeneous X-radiations in various gases. The ionisation in gaseous mixtures due to complete absorption of the corpuscular radiation have also been determined and a consideration of the result shows that the relative absorptions of energy by the gases are in agreement with their relative masses. The ionisation by X-rays of gaseous mixtures is, however, shown to differ considerably from the sum of the ionisations in the two individual gases. The difference shows the effect of corpuscles from the one gas being absorbed by the other. E. M.

1710. *Ionisation of Liquid Dielectrics by Radium Emanation.* **G. Jaffé.** (Le Radium, 10. pp. 126–134, April, 1913.)—A silvered cylindrical vessel provided with a central electrode was filled with the liquid under observation, and radium emanation introduced. The ionisation current was measured with a large p.d., and compared with that due to the same emanation in air. From the curve of rise in activity after first introducing the emanation the relative ionisation due to α- and β-rays was also deduced. The results show that in the liquids examined the ratio of the ionisation to that in air is of the order of 1/1000 for α-rays and 1/10 for β-rays. The actual ratio of the ionisation in hexane, CCl_4, and CS_2, for the same amount of emanation was 1 : 0·76 : 2·2. The small amount of ionisation in the various liquids is shown to be in agreement with the assumption that about the same number of ions are produced as in air, but owing to their being produced in columns along the small tracts of the α- or β-rays they recombine to a very large extent. This view is supported by the shape of the current-potential curve. The ionisation current was found to increase with the temperature of the liquid to about the same extent as calculated on the assumption that the only ions which carry the current are those escaping from the "columns." E. M.

1711. *Ionisation by Charged Particles.* **N. Campbell.** (Phil. Mag. 25. pp. 803–817, June, 1913.)—The paper deals with a continuation of the author's experiments on δ-rays [Abstract No. 434 (1913), etc.]. It is concluded that

primary rays of velocity less than 11 volts (fall of potential) do not cause ionisation or liberate δ-rays. Further, δ- or reflected rays never have a speed greater than that of the primary. Experiments were made on δ-rays excited by slow β-rays produced by ultra-violet light falling on a plate. Previous conclusions were verified. The various experimental results are discussed on the basis of the theory of ionisation by moving charged particles, put forward by J. J. Thomson [Abstract No. 1084 (1912)]. It is concluded that, while that theory cannot at present provide a complete explanation of the facts, it is qualitatively in agreement with them, and in no way inconsistent with them.
E. M.

1712. *Conductivity of Salt Vapours.* **G. C. Schmidt.** (Ann. d. Physik, 41. 4. pp. 673–708, July 17, 1913.)—According to these experiments, carried out on the conductivity produced by the halogen salts of zinc and cadmium, when care is taken to avoid impoverishment by the current and the surface is maintained constant, the conductivity is independent of the time. The increase of conductivity with the time, which is frequently observed at the commencement of a series of observations, is to be accounted for by the gradual manner in which the vapour reaches the sound. The decrease of the conductivity, which has been so often observed after a known time, is similarly to be accounted for by a decrease in the surface and, eventually, by an impoverishment due to the current. The hypothesis previously advanced [see Abstract No. 256 (1911)] that the decrease of conductivity is due to the change of ions into uncharged molecules of the element is not tenable. With constant surface and the avoidance of impoverishment due to current, the conductivity first diminishes with decreasing pressure, and then very rapidly increases. With increase of temperature the conductivity increases very rapidly. A. E. G.

1713. *Electrical Emissivity and Disintegration of Hot Metals.* **J. A. Harker** and **G. W. C. Kaye.** (Roy. Soc. Proc. Ser. A. 88. pp. 522–538, July 1, 1913.)—In some previous investigations, in which all experiments were conducted at atmospheric pressure, the authors obtained evidence showing that under those conditions the carriers of electricity appear to consist almost wholly of "sputtered" matter, and that corpuscles played but a minor, or at any rate an indirect, part [Abstract No. 1417 (1912)]. The present experiments were undertaken with a view to ascertaining to what extent the phenomena observed on a somewhat large scale with carbon can be reproduced with other substances. The strips of metal employed were mostly approximately 5 mm. wide and 5 cm. long between the clamps, the emitting area being about 4 sq. cm. The currents to heat them varied from about 50 to 250 amps., and the voltage across the strip from 0·5 to a maximum of about 5 volts. Full details, with sketch of the experimental arrangements, are given. These experiments on the volatilisation and electrical emissivity of metals are of a preliminary nature. The metals tested were: Platinum, iridium, iron, tantalum, nickel, copper, and brass; carbon was also used. The gas employed was mostly nitrogen at reduced pressures. It is found that emission of positive electricity occurs at temperatures from 1000° to 1400° C. For metals which melt within this range a sudden and marked increase in the positive current often occurs at the liquefying point due probably to the sudden release of occluded gas. This positive current appears to be augmented when oxygen is present. At higher temperatures negative electricity predominates, and increases rapidly with the temperature. The negative current attained with iridium at the melting-point is 80 milliamps., with tantalum at 1670° C. 220 microamps., with iron at the melting-point 90 microamps. In the case of carbon in air at atmospheric pressure an ionisation current of 8·5 amps. is obtained. The negative current at moderate pressures appears to be largely increased if the conditions are such that considerable sputtering of the metal occurs. The negative currents are probably a consequence of chemical reaction between the metal and the surrounding gas. During the experiments in which carbon was used it was found that this substance becomes plastic in the neighbourhood of 2500° C., and that at such temperatures it readily sublimes. [See also Abstract No. 1417 (1912).] A. E. G.

1714. *Canal Rays and Electronic Affinity.* **J. Franck.** (Phys. Zeitschr. 14. pp. 623–624, July 15, 1913.)—The connection between the position of a gas in the voltaic series and the charge of its canal rays, studied by Stark, Fischer, and Kirschbaum, may be explained by making the following assumption: In collisions between two atoms or molecules in which the kinetic energy is large with respect to the ionisation work of the molecule, the electro-positive molecule loses in general one or more electrons, while the electro-negative molecule acquires them. Thus, on adding electro-negative iodine vapour to electro-positive He- or Hg-vapour, many positive particles with single or multiple charges are produced. The author attempts an explanation of the "retrograde" K_1 and A_1 rays on this assumption. E. E. F.

1715. *Transmission of Canal Rays through Thin Partitions.* **A. N. Goldsmith.** (Phys. Rev. 2. Ser. 2. pp. 16–28, July, 1913.)—The object of the research was to attempt to pass the canal rays through a thin diaphram into a highly vacuous separate chamber where the spectrum of the accumulated gas, if any, could be examined free from disturbances of the electric discharge which produced the canal rays. The method of isolation of α-rays by transmission through thin partitions, so successfully employed by Rutherford, was used in the present research into the nature of the canal rays. Complete details of the apparatus employed are next given. The potentials used were at times so high that it was difficult to secure high insulation because of surface leakage over the glass. Experiments were tried in air, CO_2, hydrogen, argon, and helium. The argon was prepared by sparking air in the presence of an excess of oxygen, which excess was afterwards removed by yellow phosphorus. Helium was produced with the same apparatus, except that instead of starting with air the gas obtained by heating monazite sand was used, which, being a mixture of air and helium, affords the necessary amount of the latter with ease. Gaede and Geryk pumps permitted reaching and holding a vacuum of less than 0·0001 mm. in the apparatus. Much difficulty was at first experienced in the construction of a thin and yet gas-tight diaphragm. To begin with, Al-foil was used. It was found that the best imported foil was about 0·008 mm. in thickness, and was not at all free from holes. Indeed it was impossible to find an area of more than 3 or 4 sq. mm. which did not have a hole in it. By using the best white Indian mica and carefully splitting it up with a wedge-pointed laparotomy needle, it was possible to obtain sheets of mica of the required dimensions between 0·002 and 0·006 mm. thick, and free from all visible imperfections. These sheets of mica were sealed in place with de Khotinsky cement, which was sprinkled carefully over the sealing metal surfaces in the form of powder and then melted into a smooth film, thus ensuring gas-tight contact. Careful tests, repeated many times, established the fact that when the pressure on one side of the diaphram was 0·0001 mm. the pressure on the other side might be 2000 times as much without any perceptible leakage occurring in intervals of an hour or more. Attempts were made to identify further the moving particles which passed through the diaphram, by obtaining their electric and magnetic spectra by the method of Thomson and Wien. The apparatus was so arranged that the beam of canal rays was to pass through a magnetic field of known strength, and between Al plates maintained at a known p.d. They were then to strike a fine-grained screen of willemite, where their point of impact was to be marked by a bright spot. A considerable number of experiments with air, hydrogen, and helium showed that no bright spot could be obtained. The pressure and voltage in the tube were varied through the widest attainable limits, and powerful oscillatory discharges were sent through the main tube as well as the unidirectional discharges, while several other modifications were effected without, however, any definite bright spot being detected. The author, as a result of his experiments, draws the following conclusions :—(1) Canal rays made up of ions of hydrogen or helium can be given sufficient velocity to cause them to pass through thin material particles. (2) When the discharge tube is filled with air, CO_2, or argon, the only rays that pass through a thin partition are hydrogen. (3) When helium is used, both helium and hydrogen atoms pass through the partition, the helium in great abundance. (4) When hydrogen is used only hydrogen atoms pass through the partition, and these in large quantities. (5) The atoms which pass through such a partition are incapable of causing fluorescence on screens. H. H. Ho.

1716. *Electrical Conductivity in Cylindrical Fields at Atmospheric Pressure.* **V. Schaffers.** (Comptes Rendus, 157. pp. 203–206, July 21, 1913. Lumière Électr. 23. pp. 274–275, Aug. 30, 1913.)—To establish the theory of electrical conductivity in a gas at atmospheric pressure one of the most suitable methods is to study a continuous discharge in a field of known properties. The following conclusions are arrived at as the result of a series of observations on the initial potentials and fields in air :—The ratio of the initial positive and negative potentials is by no means determined by the mobility of the ordinary ions ; it varies regularly with the radius r of the wire. For $r = 0{\cdot}01$ cm. the two potentials are equal. It is only for radii inferior to this that the negative potential is smaller than the positive. For larger radii the converse is true. The nature of the metal seems to be indifferent, at least when the wire is not very fine. The value $r = 0{\cdot}01$ cm. separates two types with distinct laws. According to the general principles of the theory of ions the current ought to commence when the ions acquire, in a certain fall of potential, the minimum energy necessary to ionise by collision. By analogy with what is known of the discharges in rarefied gases it may be assumed that this fall ought to be 350 volts for a distance which depends only on the mean free path of the gas. It appears from these experiments that the fall of 350 volts plays no part in the initial ionisation at atmospheric pressure except in the case of fine wires. The thickness of the luminous sheath surrounding the wire is found to be between 0·04 cm. and 0·1 cm. ; there appears to be no systematic variation in this value, and it is concluded that the thickness is the same for all wires. It is shown that it is probable that in the discharges studied the masses of the ions are not invariable, but that they depend on the radius of the wire and, without doubt, obey different laws according as *r* is greater or less than 0·01 cm. When the radius of the wire is increased indefinitely the initial field tends towards 30,000 volts/cm.—the well-known value of the explosive field between electrodes of great radius of curvature. A. E. G.

1717. *Electric Dispersion in Benzol, Toluol, and Petroleum.* **N. Linnitschenko.** (Phys. Zeitschr. 14. pp. 548–555, June 15, 1913.)—Shows by three different wire-wave methods that within the range of half-wavelengths 33 to 35 cm. no dispersion bands occur either in benzol, toluol, or petroleum. The bands found by Colley, Obolensky, and others are within the limits of accuracy, and the large error attending the adjustment of the position of the front of the tank to the half-wavelength in the liquid was not sufficiently taken into account. The so-called methyl-band, supposed to be characteristic of the methyl group, has no real existence. The dispersion band found by Colley in ethyl alcohol is also doubtful, but not his results with water, which were obtained by a different method. E. E. F.

1718. *Multiple Reflection of Short Electric Waves from Screens of Metallic Resonators.* **W. L. Severinghaus** and **W. S. Nelms.** (Phys. Rev. 1. Ser. 2. pp. 411–428, June, 1913.)—The vibrator used was of the Righi type, the selective resonator screens were made by pasting tin-foil resonators on tracing cloth. The conclusions reached are as follows :—(1) The results of multiple reflection of electric waves from selective resonator screens are very similar to those of multiple or selective reflection in the infra-red. (2) Multiple reflection affords a practicable and easy mode of obtaining short electric waves of a very definite period, less damped than the oscillator waves and free from various disturbing influences. (3) The damping coefficient for resonators whose width was negligible compared to their length was found to be 0·15, which agrees with the theoretical value. The experimental value of this coefficient for the Righi vibrator is 1·4. (4) Resonators can be made to oscillate in their first overtone, *i.e.* with a frequency twice that of their fundamental. E. H. B.

1719. *Resonators for Short Electric Waves.* **W. S. Nelms** and **W. L. Severinghaus.** (Phys. Rev. 1. Ser. 2. pp. 429–445, June, 1913.)—The object of this investigation was to determine the relation of the dimensions and distribution of the resonators to the resulting wave-length. It is an application of the multiple reflection method by the same authors [see preceding Abstract]. Its results may be summarised thus :—(1) A change in the distance between resonators along the direction of electric oscillation has very little effect on the period of oscillation of the resonator. (2) For a screen of resonators the ratio of wave-length of the energy radiated to the length of the resonators depends very largely on the separation of the resonators perpendicular to the electric oscillation. (3) An increase in the width of the resonators of a given length scarcely alters the wave-length re-radiated but increases the damping of the oscillation. (4) Any resonator of width less than one-fourth its length may be taken as a linear resonator. E. H. B.

1720. *Effect of Electrical Oscillations on the Conductivity of Fused Metallic Salts.* **C. Tissot.** (Comptes Rendus, 156. pp. 1523–1525, May 19, 1913. Rev. Électrique, 20. p. 106, July 18, 1913.)—In experimenting with fused metallic salts, with a view to finding homogeneous substances for use in crystal detectors, the author noticed that when the salt consisted of a bead joining two Pt plates, of 4 mm. area and spaced 1 to 2 mm. apart, the resistance, which at first was of the order of 10^6 ohms, does not undergo much change on a p.d. being applied, so long as this is < 1 volt; but above this value the conductivity increases rapidly till the resistance is only some thousand ohms; and the more so the greater the p.d. applied. In the case of lead chloride this state of conductivity was reached in 12 mins. with 1·4 volts, in 2 mins. with 6 volts, and in 10 to 15 secs. with 10 volts applied. The applied voltage can then be progressively decreased down to some tenths of a volt without the conductivity falling back. On subjecting the substance to the influence of electrical oscillations of sufficient intensity the conductivity vanishes suddenly. The behaviour is thus what might be called a slowly self-restoring anticoherer action. Other salts found to behave similarly are: thallium chloride, cadmium bromide, the haloid silver salts, silver nitrate. The author points out that owing to the slowness of action, due to the necessity of bringing back the material to its sensitive state, the arrangement is unsuitable for use as a telephonic detector. L. H. W.

1721. *Aluminium Valves at High Frequencies.* **J. Zenneck.** (Phys. Zeitschr. 14. pp. 535–540, June 15, 1913.)—During the "formation" of Al valve-cells the decisive factor is the current density at the Al electrode. With a surface of 8 cm.^{2}, the rectifying action may set in within a few seconds, whereas with 100 cm.^{2} it is still quite imperceptible. Every current in the transmitting direction produces a "disforming" effect, whereas every current in the throttling direction produces a forming effect. The stationary state is a state of equilibrium between these two effects. The forming action, for the same current, is usually greater than the disforming action in the opposite direction. This shows that the processes at the Al electrode are not reversible. With a high-frequency alternator the influence of current density is also very marked. Thus, with an effective current of 1·96 amps. and frequency 4000 ∿ per sec. the rectifying ratio is 0·034, whereas with 5·86 amps. it is 0·281, and with 8·5 amps. 0·39. The author sketches several arrangements of Al valves as frequency transformers. E. E. F.

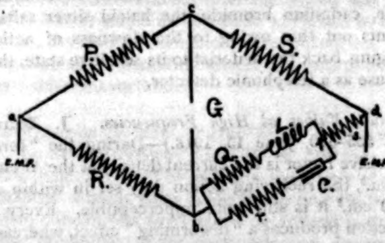
ELECTRICAL PROPERTIES AND INSTRUMENTS.

1722. *Thermoelectric Power of Silicon.* **J. Koenigsberger.** (Phys. Zeitschr. 14. pp. 658–659, July 15, 1913.)—The variation in the sign of the thermoelectric power of Si is a secondary phenomenon, probably attributable to intra-atomic magnetic fields. The Si rods examined by the author were all positive towards Cu. They contained some 5·2 % Fe. It appears that when the amount of iron varies, the thermoelectric power increases as the conductivity decreases. [See Abstracts Nos. 1394 (1911), and 1341 (1913).] E. E. F.

1723. *The Mutual Inductance of Coaxial Circles.* **J. G. Coffin.** (Phys. Rev. 2. Ser. 2. pp. 65–71, July, 1913.)—The formula given is an extension of Maxwell's series formula for the mutual inductance M of coaxial circles. If A and a be the radii of the circles and d the distance between their planes we have $M = 4\pi(Aa)^{1/2}[(2/k - k)F - (2/k)E]$, where $k=2(Aa)^{1/2}/[(A+a)^2+d^2]^{1/2}$, and F and E are the complete elliptic integrals of the first and second kind respectively. If we write, $c^2 + d^2 = r^2$, we get from the theory of elliptic functions $M = 4\pi a[\log(8a/r) . P - Q]$, where P and Q are series ascending in powers of $c^n d^m / a^{n+m}$. Maxwell carried the series as far as $n + m = 8$.

The author has computed it as far as $n + m = 8$. The correctness of the solution has been tested numerically. In most cases the inaccuracy is less than one part in a million. A. R.

1724. *Method of Comparing Inductance and Capacity.* **W. E. Forsythe.** (Phys. Rev. 1. Ser. 2. pp. 463–465, June, 1918.)—In comparing inductance and capacity by the ordinary bridge methods it is often difficult to know just what resistances to choose. This is due to the fact that there are generally two conditions of balance, the first the steady current balance, and the second the one due to the reactance; the second condition, in general, depending upon the first. It often happens that the first balance will be so chosen that the second balance cannot be obtained. In the method outlined this difficulty has been overcome by making the two conditions of balance independent. The arrangement of the circuit is given in the Fig., where P, R, S, Q, r, s are non-inductive resistances, and L is the inductance to be compared with the capacity C. It is shown that there are three conditions of balance, $S = s + Q$, $S = s + r$, $L = r^2C$. To balance the bridge make $Q = r$ and then with direct current on the bridge obtain the balance $Q + s = S$. Then with alternating current obtain the inductive balance by shifting from Q to s, keeping at the same time $r = Q$. F. E. S.



1725. *Critique and Study on the Nature of the Volta-effect.* **A. E. Hennings.** (Phys. Rev. 2. Ser. 2. pp. 1–15, July, 1918.)—Owing to difficulties and uncertainties inherent in the problem, numerous and extensive investigations have as yet produced no satisfactory explanation of the Volta-effect. It is a matter of importance, therefore, that simple and crucial experiments be devised to yield incontestable results. The primary object of this paper is to establish more firmly some of the significant facts rather than to advocate vigorously any theory in regard to the fundamental nature of the Volta-effect. Sanford's results first receive examination, since in a recent article [see Abstract No. 510 (1918)] he has described experiments the results of which, as he interprets them, furnish an effective argument against the so-called electrolytic theory of the Volta-effect. Sanford believes he has shown that the charge exhibited by an insulated conductor, such as a ball, after it has made contact with the inner surface of a hollow earthed conductor, such as a beaker, is dependent on the nature of the outside surface of the latter. This conclusion, upon which Sanford's argument is chiefly based, seemed untenable to the writer because the generally accepted facts of the phenomenon, together with incidental observations in an investigation now going on in this same field, left no doubt in his mind that the Volta-effect depends solely upon the nature of the opposed surfaces. (By opposed surfaces is meant the two metal surfaces which, with the intervening dielectric, constitute the condenser system, the charge upon which is measured in experiments upon the Volta-effect.) The author attempted to reproduce the essential elements of Sanford's experiment. The whole assemblage of apparatus was enclosed in a cage of wire netting, however, and a Dolezalek electrometer used instead of an electroscope. After several series of unsatisfactory observations it was discovered that the silk cord, which in Sanford's experiments served to insulate the ball and to raise or lower it, was invariably charged and decided induction effects produced which could not be eliminated. All the cases described by Sanford were investigated several times but none yielded results which could be interpreted as Sanford interpreted his. In spite of the disturbing influence of the charged cord, there seemed to be no doubt that the Volta-effect depended on the opposing surfaces. It is certain that in Sanford's experiments the true effect was masked to a large extent by disturbing causes. The experimental arrangements were then modified, and complete details of these are given in the paper. In order to do away with the silk cord and the attendant disturbances, it was decided to insulate the metallic beaker instead of the ball and to operate the ball with an earthed wire. It was decided also to study a larger number of cases than had been investigated by Sanford. It was found that the Volta-effect depends, under all circumstances, on the nature of the opposing surfaces of conductors which have been brought near, or in contact with, each other. All, and only such surfaces, or portions of surfaces, of conductors contribute to the general effect. The results of experiments purporting to prove otherwise are spurious. Hence Sanford's chief argument against an electrolytic theory of the Volta-effect fails because of a misapprehension in the premises. The surfaces of conductors which have been discharged to earth act just as though they were definitely and characteristically charged. In the case of a homogeneous surface this postulated electrification is uniformly distributed, while for a surface of dissimilar parts its nature and intensity vary from part to part. The surfaces being the seat of such electrical manifestations, exhibit, as a consequence, a definite p.d., the so-called e.m.f. of contact, between each other. It is only in terms of these p.d.'s that the phenomenon lends itself to quantitative treatment. The effect observed with composite surfaces has been shown to be the average effect of the constituent parts, each of which contributes in exact proportion to its extent, its relative proximity, and its own p.d. with reference to the opposing surface. The effect is practically completely "screened" when the lateral dimensions of the openings in the screen are not greater than their depth. An increase in the ratio from unity upward between the width and depth of the holes results in an increasing effect through the openings. Taken as a whole, the results show that the phenomenon has its seat in the surface. The fundamental question, then, reduces to one in regard to the actual conditions on the surface of a conductor. Is there an insulated electric layer brought into existence by chemical or other means, or are the manifestations due to intrinsic properties of the conductor which make themselves felt at its boundaries? This question is still an open one so far as the present investigation goes. H. H. Ho.

1726. *Galvanometers.* **F. Paschen.** (Phys. Zeitschr. 14. pp. 521–524, June 15, 1913.)—Gives some details of construction of mirror galvanometers for high sensitiveness and for great range of sensitiveness. A normal sensitiveness of 22,000 divisions per microamp. may be obtained by letting the needles and mirror swing in a vacuum, the period being 10 secs., the scale at

2 m., and the resistance 1 ohm. The author also describes an armoured galvanometer with a mirror 6 mm. in diam., suspended by a quartz fibre only 2 mm. long, inside a copper cylinder into which a copper piston can be introduced for electromagnetic and mechanical damping. This again fits into an iron cylinder for protection against external magnetic effects. The sensitiveness is still 1200. An instrument with a 25-mm. mirror is used for lecture experiments for currents from 100 down to 10^{-8} amps., and another as a voltmeter for 200 to 10^{-6} volts. E. E. F.

1727. *Electrothermal Phenomena at the Contact of Two Conductors : Application to Detectors.* **W. H. Eccles.** (Phys. Soc., Proc. 25. pp. 273–292; Discussion, pp. 292–293, June, 1913. Electrician, 71. pp. 900–903, Sept. 5, 1913. Abstract.)—A purely theoretical paper in which are deduced the laws connecting the current and the applied e.m.f. in a circuit containing a light contact. [See also Electrician, 71. pp. 1053–1059, Oct. 3, 1913. Paper read before the British Assoc., Birmingham, 1913.] L. H. W.

1728. *Volta-effect.* **H. Conrad.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 35–43, Jan., 1913.)—A discussion of the nature of the Volta-effect, the conclusion being that contact theory alone is insufficient to account for the observed relations, but that by help of the chemical theory an explanation is afforded. E. H. B.

1729. *Self-recording Electrometer.* **J. Patterson.** (Phil. Mag. 26. pp. 200–209, July, 1913.)—Illustrated description of an electrometer in which the principle of the thread-recorder is applied; with results. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1730. *Magnetic Properties of Vanadium Steel.* **J. J. Lonsdale.** (Phys. Zeitschr. 14. pp. 581–589, July 1, 1913.)—Using the ballistic ring method, and the vanadium steel first in its original state, then annealed, chilled, and re-annealed, the author found that by heating beyond the critical temperature and either annealing or chilling the magnetic hardness is increased. The permeability is less than that of other steels containing the same amount of carbon, and the hysteresis and coercive force are greater. E. E. F.

1731. *Magnetisation of Manganese, Manganese-Copper, and Chromium.* **K. Ihde.** (Ann. d. Physik, 41. 4. pp. 829–853, July 17, 1913. Extract from Inaug. Dissertation, Marburg.)—The specimens tested were (1) solid manganese; (2) the same after quenching at 600° C.; (3) another Mn rod quenched and then aged by heating at 140° for 150 hours; (4) four powders of same material as (1); (5) a Mn powder mixed with gypsum; (6) a chemically pure Mn powder; (7) 30 per cent. manganese copper; (8) solid chromium; (9) two Cr powders. These were tested by means of the attraction method in which a cylinder hangs from the arm of a balance, with its lower end between the poles and on the axis of an electromagnet. Formulæ were obtained for determining the susceptibility of both para- and ferro-magnetic bodies, and the curves which are shown for the Mn powders under (4) and (5), the Mn-Cu, and the Cr powders under (9) follow the course of the typical ferromagnetic curve, showing a definite maximum for a given field. In the other cases, the susceptibility diminishes as H increases, and the maximum is already overstepped in fields of 1000 gauss. The ferro-magnetism cannot be ascribed to the iron-content. Mn has been stated as paramagnetic by Gebhardt, Honda, and Weiss, whilst Seckelson and Weiss have obtained it in the ferromagnetic condition. [See Abstract No. 785 (1910).] G. E. A.

1732. *Disappearance of Ferro-magnetism under Short Electric Waves.* **W. Arkadief.** (Phys. Zeitschr. 14. pp. 561–562, July 1, 1913.)—Measurements of the absorption of undamped electric waves by parallel wires show that the difference between magnetic and non-magnetic wires tends to disappear at the higher frequencies. In the case of soft-iron wire, 0·22 mm. in diam., the magnetic permeability for a wave-length of 1·31 cm. is only 6 per cent. of the value for $\lambda = 72{\cdot}7$ cm. For wave-lengths about 2 cm. nickel possesses a permeability no greater than that of air. E. E. F.

1733. *Magnetic Observations during Solar Eclipse,* 1912, *April* 17. **G. van Dijk.** (Terrestrial Magnetism, 18. pp. 51–53, March, 1913.)—With reference to the observations mentioned by O. H. Tittmann [Abstract No. 989 (1912)] the present note is given for comparison of the magnetograph registrations at De Bilt during the time of the solar eclipse of 1912, April 17. From the character figures for the month of April deduced from 42 magnetic observatories it is shown that the rather quiet beginning of the month was followed by a more or less disturbed period from April 14–20; on April 21 a new series of quiet days began. In spite of the general disturbed condition, the declination curve for De Bilt shows the effect of the eclipse, the increase of the declination in the forenoon being less than ordinarily. Tables are given showing the values of declination, horizontal and vertical intensity for every 5 minutes from 9h. to 15h. (G.M.T.) on the day of eclipse, and a figure showing the changes graphically. C. P. B.

1734. *Sun-spots and Terrestrial Magnetic Phenomena.* **A. L. Cortie.** (Roy. Astronom. Soc. M.N. 73. pp. 431–436, April, 1913.)—From a study of the solar phenomena and terrestrial magnetic changes during the period 1898–1911 it is concluded that:—(1) There was a lag of the maximum of frequency of magnetic storms upon sun-spot area, and an inversion of the phenomenon in the latter half of the cycle. (2) After the maximum of a sun-spot cycle the earth is more favourably situated relatively to the zones of spot activity, depending on the inclination of the sun's axis to the ecliptic. (3) The minima in the curve of annual variation of magnetic storm frequency occur near the nodes of the sun's equator, and the maxima near points removed 90° from the nodes. (4) The inclination of the sun's axis to the ecliptic, and the position of the earth relative to the sun-spot zones, would cause such an inequality. (5) A greater magnetic storm is independent of the area of the associated sun-spot and of its position relatively to the central meridian. (6) Spots associated with greater magnetic storms are marked by continual change and by irregularity of structure. (7) Not one, but several, magnetic storms mark the passage of an active spot across the sun, suggesting that the mode of action of a spot is by a series of streams diverging from a disturbed area. (8) In the eclipses of 1898, 1905, 1908 there is evidence that long-enduring belts of solar activity, which were associated with synodical series of magnetic storms, are marked in the solar corona by converging sets of streamers. [See Abstracts Nos. 701 and 877 (1913).] C. P. B.

1735. *New Analytical Expression for Magnetic Variation.* **G. W. Walker.** (Roy. Soc., Proc. Ser. A. 88. pp. 191–194, March 31, 1913.)—Since the usual

Fourier representation of the magnetic diurnal variation does not converge rapidly, it may be doubted whether the 12-hour, 8-hour, 6-hour, etc., terms really correspond to a definite physical cause, and it may be that the phenomena are simply diurnal. By trial it has been found that the combination of curves of the form $y \propto \sin t/(1 + k \cos t)$, and $y \propto \cos t(1 + k \cos t)$ gives a resultant curve remarkably resembling the characteristic declination record for either Kew, Potsdam, or Paris. Working from this it is suggested that the general form—

$$y = -k\,\frac{(k_1 \sin t + k_2 \cos t)}{1 + k \cos t} + k_2 \left\{ 1 - \frac{1}{(1 - k^2)^{\frac{1}{2}}} \right\}$$

may prove suitable for the expression of magnetic variations. C. P. B.

1736. *Coefficient of Magnetisation of Water and Oxygen.* **A. Piccard.** (Archives des Sciences, 35. pp. 209–231, March; 340–359, April, and pp. 458–482, May, 1913.)—A more detailed account of methods of measurement and results already described [see Abstracts Nos. 518, 519 (1913)]. T. H. P.

1737. *Land Magnetic Observations,* 1905–1910. **L. A. Bauer.** (Researches of the Department of Terrestrial Magnetism [185 pp.], Carnegie Inst., Washington, 1912.)—The first publication of a series in which it is proposed to publish the results of the operations and researches conducted by this Department. L. H. W.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1738. *Influence of Variation in Number of Interruptions of Primary Current on the Output of a Ruhmkorff Coil.* **Nogier** and **Regaud.** (Archives d'Él. Médicale, 21. pp. 59–68, July 25, 1913.)—With a soft bulb it is shown that as the velocity of interrupter is increased, the current through the secondary increases, while the spark equivalent and the amps. in the primary decrease. With a hard bulb a decrease in the rate of interrupter causes the milliamps. in the secondary to increase; the spark equivalent and the amps. in the primary also increase. The bundle of Röntgen rays is enriched in hard rays, so that in this form the apparatus is at its best for the production of very penetrating rays. These facts are in complete agreement with a theory outlined in the paper. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1739. *Electrical Goniometer Furnace for the Measurement of Crystal Angles and of Refractive Indices at High Temperatures.* **F. E. Wright.** (Washington Acad. Sci., Journ. 8. pp. 396–401, Aug. 19, 1918.)—An electric furnace is described which can be mounted on a Goldschmidt's two-circled goniometer and used for goniometric measurements up to 1150° C. The furnace is made of alundum, heated by Pt-wires, and cooled externally by water-jackets. The crystal is mounted in Pt-jaws and adjusted before the furnace parts are set in position. Its temperature is determined by a thermo-element in direct contact with it, the wires being led out through porcelain tubes. Preliminary measurements on a cleavage rhomb of calcite showed that the angle changed from 74° 55′ at 30° C. to 75° 52′ at 600°, the change being about 1 minute of angle for each 10 deg. C.; it is therefore useless to give readings to seconds of arc unless the temperature is also given. T. M. L.

1740. *Optical Investigation of Solidified Gases.* III. *Crystalline Properties of Chlorine and Bromine.* **W. Wahl.** (Roy. Soc., Proc. Ser. A. 88. pp. 348–353, June 2, 1918.)—Chlorine crystallises in forms belonging to the orthorhombic system, the optical extinctions being parallel and perpendicular to a principal axis: there is also a distinct cleavage parallel to this axis. Polarised light travelling parallel to the cleavage and principal axis is more strongly absorbed, and the transmitted light is of a deeper yellow, with a greenish tint, than is the polarised light passing in directions perpendicular to this principal axis. There is also a slight difference in the degree of absorption in the two directions at right angles to the principal axis. No dimorphic change was observed on cooling the crystals to the temperature of liquid air.

Crystallised bromine resembles chlorine, but its properties are more pronounced. The crystals are orthorhombic, and have a tendency to develop in prisms, with a prismatic cleavage at an angle of about 70°; at low temperatures there is also a cleavage parallel to the basal plane. The absorption is: Dark brownish-red in the direction of the prism axis, yellowish-red in the direction of a line bisecting the smaller prism angle, and pale yellowish-green in the direction of the line bisecting the larger prism angle. This trichroism is diminished by cooling with liquid air, the brownish-red becoming yellowish-red and then yellow, whilst the yellowish-red becomes pale yellow. No polymorphic change was observed on cooling with liquid air.

Iodine crystallises in the orthorhombic system with a prism angle of 67° 12′. Monoclinic prisms are formed by sublimation below 46·5° C.; this form is also obtained by the rapid evaporation of solutions in CS_2, $CHCl_3$, alcohol and petroleum-ether, but it is probably only a sporadic monotropic modification, as it cannot be produced by cooling the ordinary orthorhombic form even to —180°. The orthorhombic form is strongly trichroic. The light is almost totally absorbed when the direction of the principal axis is parallel to the plane of polarisation; the light transmitted at right angles to the principal axis of extremely thin films is either light reddish-brown or light leather-brown, the colour becoming much paler when the films are cooled.

The study of the melting-point curves has shown that the three elements form a complete series of mixed crystals, and are thus perfectly isomorphic. It is of interest that the strongest absorption in chlorine resembles the weakest in bromine, whilst the strongest absorption in bromine resembles the weakest in iodine. T. M. L.

1741. *Chemical Action of the Penetrating (β and γ) Radium Rays.* V. *Cane Sugar.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2127–2132, Dec., 1912.)—The experiments show that cane sugar in sterilised tubes is inverted by exposure to the penetrating rays just as in unsterilised tubes [Abstract No. 716 (1913)], but to a much less extent. The diminution of rotative activity and of resulting acids was of about the right amount supposing the H_+ ions to cause the inversion. The resulting solution reduced Fehling's solution. E. M.

1742. *Solubility of Radium Emanation in Water.* **M. Kofler.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2169–2180, Dec., 1912.)—A flask of volume V was taken and filled with volume v of water, and radium emanation introduced. The relative quantities E′ and E of emanation present in the liquid and gas above the liquid were measured at different temperatures. The following are the values of the ratio of the concentrations found $\alpha=(V-v)E'/vE)$ 0·5° C., 0·526; 17·5° C., 0·283; 41° C., 0·161; 60° C., 0·127; 79° C., 0·111; 91° C., 0·108. E. M.

1743. *Concentration of Polonium.* **F. Paneth.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2193–2194, Dec., 1912.)—The experiments show that polonium can be separated from RaD and lead by diffusion through parchment which retains the Po-salt but lets $Pb(NO_3)_2$ through. E. M.

1744. *Solubility of Active Deposit of Radium.* **E[va] Ramstedt.** (Le Radium, 10. pp. 159–165, May, 1913.)—A piece of well-polished and cleaned glass was suspended in radium emanation so as to become activated. After measuring its activity it was dipped in any particular solution for a known interval of time. After carefully drying, its activity was again measured and the subsequent variation with time. From these observations the solubility of the various products was determined. It was found that metals like Au and Pt give anomalous results, presumably on account of adhering gases; consequently glass was used. It was further found that half the activity was easily dissolved while the other half was scarcely soluble, and this is presumed to be due to RaA being first deposited on the glass, and by recoil half the resulting RaB embedded just underneath the surface. With Au or Pt, however, the portion easily soluble under similar conditions was from 60 to 70 %. As a result of the experiments tables are given of the solubilities of A, B, and C in the various reagents. The main conclusions are:—(1) RaC is soluble in HCl, H_2SO_4, HNO_3, and acetic acid, less soluble in water, NH_4OH, and Na_2CO_3, and very little soluble in organic liquids. (2) RaB dissolves easier in water and dilute acids than RaC, less easily in alkaline solutions, and very little in organic liquids. (3) RaA dissolves to a slightly smaller extent in acids than RaC but more easily in organic liquids. (4) The rate of solution increases with temperature and at the same rate for RaB as RaC. (4) Exposure to oxygen diminishes enormously the solubility of the products. E. M.

1745. *Active Nitrogen.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 88. pp. 539–549, July 1, 1913.)—To meet the objection that his nitrogen was not free from oxygen, the author lets his nitrogen stand over phosphorus for hours, until it does not contain 1 part of oxygen in 100,000. The presence of oxygen in his active nitrogen is really injurious, and 2¼ % of oxygen would be fatal. Water-vapour is likewise harmful even in traces; hydrogen and CO_2 have little effect. When vapours of Hg, Cd, Zn, As, Na, S are added to the active nitrogen, nitrides (yielding ammonia) are formed. A stream of CS_2 leads to a deposition of blue NS, and further of brown polymeric CS apparently. The chlorides of sulphur, tin (stannic) and titanium (tetrachloride) give with active nitrogen brilliant colour effects and solid deposits. Many organic compounds, acetylene, benzene, chloroform, ether, etc., yield hydrocyanic acid, but not cyanogen, though cyanogen chloride is formed in the presence of chlorine; benzene seems to yield cyanobenzene. The intensity of the cyanogen spectrum during these reactions is no index of the quantity of HCN formed, and there is in general no connection between the development of the spectra and the chemical action in progress. H. B.

1746. *Preparation of Molybdenum and Tungsten Carbides.* **S. Hilpert** and **M. Ornstein.** (Ber. Deut. Chem. Gesell. 46. 8. pp. 1669–1675, 1913. Chem. News, 108. p. 96, Aug. 22, 1913. Abstract.)—When the finely powdered metals (or also the trioxides) are heated in CO or in mixtures of CH_4 and H (the H being added to prevent dissociation of the $CH_4 \rightleftarrows C + 2H_2$) different carbides are formed at different temperatures. In the case of Mo and CO, MoC is produced at 600 and 1000°; at 800° the composition varies between MoC and Mo_2C_3. Tungsten yields W_3C_4 in CO at 1000°; in a mixture of one methane and one hydrogen, WC is formed at 800°. H. B.

1747. *Do Molecules attract Cohesively Inversely as the Square of the Distance?* **A. P. Mathews.** (Journ. Phys. Chem. 17. pp. 520–535, June, 1913.)—Mills (Ibid. 15. p. 417, 1911) has shown that for most substances, excepting near the critical temperature, close approximation to constancy is shown by the expression $(L - E)/(\sqrt[3]{d} - \sqrt[3]{D})$, where L represents the latent heat, E the corresponding external work and D and d are the respective densities of liquid and vapour. The author confirms this constancy for a number of substances. The accuracy of the assumption that this constancy demonstrates that molecules attract inversely as the square of the distance depends, however, on the accuracy of the supposition that $(L - E)$ represents only the work done in separating the molecules against their molecular cohesion. The author shows, indeed, that the total latent heat, L, must be composed of three factors, $A + E + I$, where I represents the heat consumed in increasing internal molecular potential energy by expanding the molecule or increasing its energy of rotation. That such expansion does actually occur in passing from liquid to vapour follows from the author's calculations of the values of the van der Waals' constant, b, for pentane, benzene, etc. Hence, it cannot be affirmed that molecular attraction follows an inverse square law.

On the other hand, van der Waals' relationship, $L - E = a(d - D)$, is correct only close to the critical temperature where I is very small and should be changed to the form $L - E - I = a(d - D)$. Unless I is determined independently, this expression cannot be tested for different temperatures, but, as would be expected from it, it is found that $(L - E)/(d - D)$ has increased values at temperatures below the critical one. For hexane the value of I increases from zero at the critical point (234·5°) to 28·21 cals. per 1 gm. at 0°. It is pointed out that, as has been shown by Sutherland, the correct expression for the increase of molecular potential energy, $a(d - D)$, is deduced very simply on the assumption that the molecules attract inversely as the fourth power of the distance. T. H. P.

1748. *Significance of the Relation between Molecular Cohesion and the Product of the Molecular Weight and the Number of Valencies.* **A. P. Mathews.** (Journ. Phys. Chem. 17. pp. 481-500, June, 1913.)—The author has shown [Abstract No. 1096 (1913)] that the value of the van der Waals constant *a*, which represents molecular cohesion, or of M^2K, which is the constant *a* for a single molecule, is proportional to the two-thirds power of the product of the molecular weight by the number of valencies of the molecule; in absolute units, $M^2K = 2{\cdot}98 \times 10^{-37}$ (mol. wt. × number of valencies)$^{2/3}$. The relationship of cohesion to these molecular properties is now discussed in its theoretical bearings. This relation can be interpreted best, and apparently only, by J. J. Thomson's theory of the electrical constitution of matter and valency, so that cohesion must be regarded as an electrostatic or, more probably, electromagnetic phenomenon. From the results of experiments on the relation between valency and dispersion, Drude [Abstract No. 3241 (1904)] was led to the suggestion that the electron couples constituting the molecules are of two different kinds: (1) those of the atoms themselves, the sum of which presumably gives the molecular weight, and (2) those of valency, which alone are sufficiently free to vibrate synchronously with light and are hence particularly concerned in the refraction and dispersion of light. This conclusion is confirmed by the author's investigation of cohesion.

The general result arrived at in the present consideration of the question is that cohesion, being a function of molecular weight and valency, is a function of the number of electron couples of the valencies and atoms, and is hence probably magnetic in nature. Magnetic substances may be supposed to be those in which, owing to the orientation, or to the polarity, or to both, of the molecules, the cohesive fields of the molecules are not delimited or neutralised by the surrounding molecules, the cohesional attraction thus becoming apparent at distances greater than molecular distances. T. H. P.

1749. *Relation between the Thermal Effect accompanying the Immersion of a Dry Powder in a Liquid, and the Tendency of the latter to Associate.* **H. Gaudechon.** (Comptes Rendus, 157. pp. 209-211, July 21, 1913.)—Measurements have been made of the amounts of heat disengaged on immersion of (1) so-called amorphous silica, (2) natural clay, (3) powdered sugar-charcoal, and (4) starch, previously dried at 100°, in water, various alcohols and other organic liquids. It is found that the amounts of heat vary according to the normality or abnormality of the liquids as regards the values of the coefficient K of the Eotvos-Ramsey-Shields relation and of the expression LM/T of the Pictet-Trouton relation. The more abnormal the liquid, the greater is the amount of heat developed, the latter tending towards zero for normal liquids. Thus water, alcohols, acids, and other compounds containing the hydroxyl group give the largest heat-effects, clay giving, for example, ten times as much heat with water as with saturated hydrocarbons. Also, in an homologous series, the thermal effect diminishes as the series is ascended, in accord with the decreased tendency to associate. It is hence evident that the amount of heat disengaged depends mainly on: (1) the abnormality of the liquid, and (2) the ratio of the surface of the solid to its mass, increase of this ratio causing increased evolution of heat.

T. H. P.

1750. *Applications of the Hydrogen Electrode in Analysis, Research, and Teaching.* **J. H. Hildebrand.** (Amer. Chem. Soc., Journ. 35. pp. 847–871, July, 1913.)—Attention is called to the value of the hydrogen electrode as an indicator in titrations, as proposed by Böttger. Apparatus is described whereby titrations can be made with ease and rapidity. Curves are given representing titrations of a number of acids, bases, and salts. These curves illustrate the difference between acids and bases of different strengths, the distinction between normal and neutral salts, and the phenomena of hydrolysis. The curves provide the most reliable method that is known for choosing indicators. The large effect of certain salts and other substances on the colour change of many indicators makes it unsafe to rely solely on calculations from dissociation constants, even where these are known, and the selection of the indicator from tables such as those of Salm. In difficult cases the only sure method is to have the probable indicator present while titrating with the hydrogen electrode, and see if the indicator changes colour at the point of inflection of the curve. The hydrogen electrode can be used alone for titrations where some circumstance such as the colour of the liquid prevents the use of an indicator.

A number of precipitations have been studied by this means, and illustrations are given to show how separations of metals may be predicted and controlled.

A method is described for the rapid determination of magnesium in the presence of calcium.

If instead of a hydrogen electrode an unattackable electrode is submerged in the liquid, it is possible to follow oxidation and reduction reactions. Thus the titration of ferrous iron with dichromate by this method is superior in speed and accuracy to the use of an external indicator. T. M. L.

1751. *Criticism of Recent Viscosity Investigations.* **E. C. Bingham.** (Chem. Soc., Journ. 103. pp. 959–965, June, 1913.)—Attention is directed to the necessity of making a correction for the kinetic energy of the liquid escaping from the capillary of a viscometer. A rapid rate of flow is an advantage, as it checks the clogging of the capillary by particles of dust; the velocities required to produce an eddying flow are well known, and it is easy to keep within safe limits.

There is much evidence to show that in simple cases, in which association and dissociation do not come into account, the *fluidity* of a liquid mixture is a linear function of the concentration. If so, it is impossible for the viscosity to be a linear function, and no evidence of chemical changes is afforded by deviations of the viscosity-concentration curves from a straight line. T. M. L.

1752. *Correlation of Physical Properties of Solutions.* IV. *Refraction, Dispersion, and Dissociation of Salts in Water.* **A. Heydweiller.** (Ann. d. Physik, 41. 3. pp. 499–542, June 24, 1913.)—The experimental data for the refraction and dispersion of light in salt solutions are collected from a series of four dissertations and tabulated. The refractive index of a given solution may be expressed by the formula $n = 1·33327 + 4m/300 . \Delta_n$, where m is the concentration in gm.-equivalents per litre, 1·33327 (or 4/3 approximately) is the refractive index of water, and Δ_n is a constant for a given solute. The formula $\Delta_n = B_n + (A_n - B_n)i = A_n i + B_n(1 - i)$ is given to express the relationship between the refractive power of the solute and its ionisation. The refractive power A_n of the ionised solute is an additive function of two moduli for the anion and kathion respectively. These moduli are deduced on the assumption that in solutions of hydrogen chloride, the refractive powers of the hydrogen and chlorine ions are in the same ratio (1 : 5·5) as in the two gases. These moduli are approximately integral multiples of a constant 0·029. The author also discusses the refraction equivalents of dissolved substances according to the formula of Lorenz and Lorentz, with the ionic moduli for this function, the relation of atomic weight to ionic volume and ionic diameter, and finally the dispersive power of salts and of ions in the visible and ultra-violet regions of the spectrum. [See also Abstract No. 1125 (1912).] T. M. L.

1753. *Effect of Interionic Forces of the Osmotic Pressure of Electrolytes.* **S. R. Milner.** (Phil. Mag. 25. pp. 742–751, May, 1913.)—A thermodynamical treatment.

1754. *Electrolytic Regeneration of Chromic Acid from Sulphate Solutions.* **P. Askenasy** and **A. Réval.** (Zeitschr. Elektrochem. 19. pp. 344–362, April 15, 1913.)—According to D.R.P. 199,248 and Brit. Pat. 9636 of 1907, G. Adolph and A. Pietzsch avoid, in the regeneration of chromic acid from chromium sulphate in cells without diaphragm, the kathode reduction by adding alkali sulphate or acetate to the electrolytic; the addition is to lower the kathode potential. The authors submit this process to a searching inquiry; they review the literature, and explain under what conditions the process can technically be carried on without diaphragm. The concentration of chromic acid should not exceed 100 gm./litre; when the kathode current density exceeds 200 amps./dm.^{2}, which is advisable, no salt addition is required; when not, additions should be made cautiously; the addition of magnesium or of chromium sulphate may be profitable, but it all depends upon the current density and concentration relations. H. B.

1755. *Electrolytic Separation of Copper from Tungsten and Molybdenum.* **W. D. Treadwell.** (Zeitschr. Elektrochem. 19. pp. 219–221, March 1, 1913.)—The electrolytic separation of Cu from W and Mo does not succeed in KCN solution. But copper in various salts can be separated from W (as sodium tungstate) in solution of concentrated ammonia by currents of 2 volts, with stationary or rotating electrodes. The separation of Cu from Mo (as ammonium molybdate) requires the presence of alkali sulphite and an e.m.f. of 0·9 volt; the current must in this case be interrupted within a few mins. after the disappearance of the blue colour. The molybdenum trioxide should not be heated above 450°, and not in a Pt crucible; a porcelain crucible should be used. H. B.

1756. *Electrolytic Preparation of Calcium and Calcium Alloys.* **W. Moldenhauer** and **J. Andersen.** (Zeitschr. Elektrochem. 19. pp. 444–447, June 1, 1913.)—Contrary to the usual statements it is possible to obtain metallic calcium free from potassium or alloys with zinc or lead (forming the fused kathodes) from mixtures of the chlorides of Ca and K. The authors study the melting-points of the chloride mixtures. The mixture $85CaCl_2 + 15KCl$, melting at 680° C., yields pure Ca or pure alloy (Zn-Ca containing up to 67 per cent. of Ca, and Pb-Ca up to 82 per cent. of Ca), by the Rathenan method and currents of 60 to 110 amps./cm.^{2}, at a current efficiency of 90 per cent. maximum. The mixture $40CaCl_2 + 60KCl$ is unsuitable. The "pure" calcium generally contains less than 0·1 per cent. of potassium, but it may enclose 8 per cent. of the fused electrolyte. H. B.